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US ARMY
AVIATION
SYSTEMS COMMAND

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FLAPS-UP TAKEOFF PERFORMANCE OF THE OV-1D AIRCRAFT WITH YT53-L-704 ENGINE INSTALLED

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FINAL REPORT

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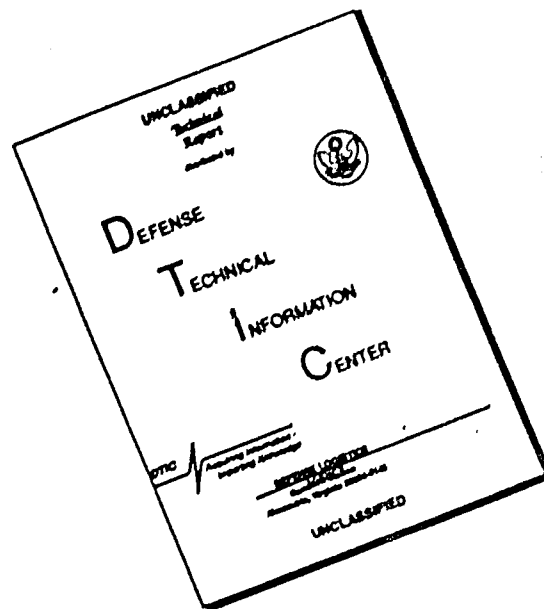
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19. ABSTRACT (Continue on reverse if necessary and identify by block number) The U.S. Army OV/RV-1D operational units have requested flaps-up takeoff authorization procedures and performance data to allow quicker acceleration to best single-engine climb speed (V _{yse}). Test results indicated that flaps-up takeoff procedures require slightly more distance to lift-off, but less time and distance to attain V _{yse} and 200 feet above ground level than flaps-15 takeoff procedures. Flaps-up takeoffs eliminate a step in the emergency procedure (bringing the flaps-up). The flaps-up procedure eliminates the portion of the takeoff profile where the aircraft cannot accelerate because the flaps are down and the flaps cannot be retracted because the airspeed is below flaps-up minimum control speed. Flaps-up procedures avoided the temporary altitude loss which occurred with the flaps-15 takeoff procedure when the flaps were retracted at high gross weight/density altitude conditions. Flaps-up takeoffs should be incorporated into operational unit procedures. Accelerate-stop distance using wheel brakes only was excessive. The brakes became overheated and ineffective. The ineffectiveness of the OV/RV-1D wheel brake system is a deficiency.																	
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A procedure using aerodynamic braking with speed brakes and a flaps-45 setting was developed and used effectively to slow the aircraft until elevator effectiveness was lost, then wheel brakes were used to bring the aircraft to a stop. The aerodynamic braking procedure should be incorporated into the Aircrew Training Manual program. An anti-skid wheel brake system should be incorporated on the OV/RV-1D aircraft. Single-engine ground minimum control speed (V_{mcg}) was 55 knots indicated airspeed (KIAS) for flaps-up and 50 KIAS for flaps-15. OV-1D V_{mcg} characteristics are satisfactory. The 15 knot crosswind component limitation in the all stores configuration is valid for flaps-up takeoff procedures. Engine response characteristics evaluated at 20,000 and 25,000 feet pressure altitude were satisfactory. Engine air restart could not be achieved at pressure altitudes above 19,000 feet. Engine firewall temperatures were excessive (above 315°C) for power settings above 70 percent torque with the infrared suppressor system installed both on the ground and in low speed flight. An Active Noise Reduction system, which was evaluated during this program, has potential for reducing the excessive cockpit noise level at high power/propeller speed settings.

TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	
Background.....	1
Test Objectives.....	1
Description.....	2
Test Scope.....	2
Test Methodology.....	2
RESULTS AND DISCUSSION	
General.....	4
Takeoff Performance.....	4
Takeoff.....	4
Crosswind Takeoffs and Landings.....	6
Ground Minimum Control Speed.....	7
Accelerate-Stop Distance.....	8
Engine Response Characteristics.....	10
Engine Firewall Temperature Survey.....	10
Human Factors.....	10
CONCLUSIONS	
General.....	12
Deficiencies.....	13
Shortcoming.....	13
RECOMMENDATIONS.....	14
APPENDIXES	
A. References.....	15
B. Description.....	16
C. Instrumentation.....	21
D. Test Techniques and Data Analysis Methods.....	23
E. Test Data.....	32

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INTRODUCTION

BACKGROUND

1. U.S. Army OV/RV-1D operational units have requested flaps-up takeoff authorization, procedures and performance data to allow quicker acceleration to the best single-engine climb speed (V_{yse}). Prior U.S. Army Aviation Engineering Flight Activity (AEFA) evaluations have shown significant improvements in single and dual engine climb performance of the OV-1D with the YT53-L-704 engines installed. This evaluation expanded and added to the takeoff performance data available for operation with increased power available from YT53-L-704 engines. The U.S. Army Aviation Systems Command (AVSCOM) tasked AEFA (ref 1, app A) to evaluate flaps-up takeoff performance of the OV-1 with T53-L-701 and YT53-L-704 engine power levels.

TEST OBJECTIVES

2. The primary objective of this evaluation was to determine the effects on OV-1D takeoff performance of using flaps-up setting compared to the standard flaps-15 setting. Specific objectives were to determine:

a. Flaps-up and flaps-15 takeoff performance for power levels representative of both the T53-L-701 engine and the YT53-L-704 engine.

b. If V_{yse} can be more safely achieved using flaps-up takeoff procedures.

c. Accelerate-stop distance using flaps-up takeoff procedures.

d. The single-engine ground minimum control speed (V_{mcg}) for flaps-up and flaps-15 degree takeoff configurations.

e. The YT53-L-704 engine response and restart characteristics at 20,000 and 25,000 feet pressure altitude.

f. The engine firewall temperatures at T53-L-701 and YT53-L-704 engine power levels with and without the Louvered Scarfed Shroud Suppressor (LSSS).

g. The effectiveness of an Active Noise Reduction (ANR) System.

DESCRIPTION

3. The OV-1D(C) test aircraft, S/N 62-5867, is a two-place, twin engine turboprop aircraft with a midwing, triple vertical stabilizers, and tricycle landing gear. Seven external store stations, including the fuselage, may be used to carry a variety of surveillance pods and/or fuel tanks. For this program, the aircraft was tested with two 150 gallon drop tanks, Side Looking Airborne Radar boom, and the AN/ALQ-147(V)1 infrared system installed. The LSSS was installed for the firewall temperature survey. A more detailed description of the OV/RV-1D aircraft is contained in the operator's manual (ref 2, app A). The test aircraft was powered by YT53-L-704 engines rated at 1800 shaft horsepower (shp) at sea level standard day conditions. A prototype Safe Flight Instrument Corporation stall warning system was installed.

TEST SCOPE

4. Flaps-15 and flaps-up takeoff performance and handling qualities, V_{mcg} and accelerate-stop evaluations were conducted at the conditions in table 1. Engine shutdown, restart, acceleration, and deceleration characteristics were evaluated at 20,000 feet pressure altitude. Engine acceleration and deceleration characteristics were evaluated at 25,000 feet pressure altitude. A temperature survey of the firewall inside the engine cowling was conducted with and without LSSS installed. Sawtooth climbs with the LSSS installed were not conducted as planned because of excessive engine nacelle temperatures. A total of 20 flights requiring 13 flight hours (10 productive flight hours) were conducted between 2 September 1986 and 12 March 1987. Flight restrictions and operating limitations were established by an airworthiness release (ref 3) issued by AVSCOM prior to the start of the test.

TEST METHODOLOGY

5. Established engineering flight test techniques and data reduction procedures were used during this evaluation (refs 4 and 5). The test methods are briefly described in the Results and Discussion section of this report. A more detailed description of the test techniques and data analysis methods may be found in appendix D. Data were recorded on magnetic tape onboard the aircraft for all tests and transmitted through telemetry to the Real Time Data Acquisition and Processing System for the takeoff, V_{mcg} , decelerations, accelerate-stop and engine response

characteristics tests. Appendix C contains a list of the test instrumentation. An airspeed system calibration was completed using the measured ground course procedure. A low speed (40 to 100 knots indicated airspeed (KIAS) calibration was completed using the Del Norte space positioning system. A weight and balance was completed prior to first flight.

RESULTS AND DISCUSSION

GENERAL

6. OV-1D takeoff performance and handling qualities evaluations showed that flaps-up takeoff procedures provided quicker acceleration to $V_{y_{se}}$. Crosswind takeoffs with the flaps-up verified that the 15 knot 90 degree crosswind component limit is valid. Accelerate-stop distance was approximately 500 feet greater for flaps-up procedures than for flaps-15 procedures. Due to excessive brake temperatures, the stop procedure had to be changed to incorporate aerodynamic braking with the speed brake extended and the flaps-45 setting. The inability of the OV-1D brake system to stop the aircraft from an aborted takeoff at rotation speed is a deficiency. The use of aerodynamic braking using speed brakes and flaps-45 setting to stop the aircraft after an aborted takeoff should be incorporated into the Aircrew Training Manual and handbook procedures. An anti-skid system should be incorporated on the OV/RV-1D brake system. Single-engine ground minimum control speed at 18,200 pounds for T53-L-701 power levels (100 percent torque, 1536 shp) was 55 KIAS for flaps-up compared to 50 KIAS for flaps-15 takeoff procedures. YT53-L-704 engine response characteristics were evaluated at 20,000 and 25,000 feet pressure altitude and were excellent, however, restart could not be accomplished above 19,000 feet pressure altitude. Engine response and sawtooth climb tests with LSSS installed were not conducted due to excessive firewall nacelle temperatures. Excessive engine firewall temperatures were observed for the ground run tests and during slow flight at power settings above 70 percent torque with LSSS installed.

TAKEOFF PERFORMANCE

Takeoff

7. Takeoff performance tests were conducted at the conditions presented in table 1 from a level, dry, hard surfaced runway at Edwards AFB, California (elevation 2302 feet) and at Alamosa, Colorado (elevation 7535 feet). Handbook takeoff trim settings were used for all takeoff tests. Lift-off distance, distance to clear obstacles up to 200 feet, and time and distance to reach $V_{y_{se}}$ were determined using the Del Norte Space Positioning system in conjunction with installed aircraft instrumentation. A standard calibrated production ship's system airspeed indicator was used for the reference speeds. Wind velocity was 10 knots or less. Lift-off speed was 1.1 times the velocity for minimum control (V_{mc}) determined during USAAEPA Project Nos. 85-16 and 85-17. Power was set at 46 percent torque prior to brake release. Rotation speed was lift-off speed minus 3 KIAS. The gear (and

Table 1. Test Conditions¹

Test	Takeoff Gross Weight (lb)	Pressure Altitude (ft)	Power Setting (shp)	Flaps Configuration (deg)	LSSS
Takeoff Performance ²	16,500 18,200	Edwards ³	800 1000 1200 1400 1600 1800	0 and 15	OFF
		Alamosa ⁴	800 1000 1200 1400 1600 MAX		OFF
Crosswind Takeoffs and Landings	16,000	Edwards	1536	0 and 15	OFF
Decelerations	14,800 16,500 18,600	Edwards	N/A	0, 15, 45	OFF
Single-Engine Ground Minimum Control Airspeed	18,200	Edwards	1536	0 and 15	OFF
Accelerate-Stop Distance	14,900 16,500 18,200	Edwards	1536	0 and 15	OFF
Engine Response Characteristics ⁵	16,000	Edwards	1536	0 and 15	OFF
Engine Firewall Temperature Survey ⁶	16,500	Edwards and 10,000	200 to 1800 ⁷	0	ON and OFF

NOTES:

¹Tests were conducted at a mid center of gravity (forward cg for takeoff performance only) with the following external stores configuration: SLAR, 150 gallon drop tank at wing stations 3 and 4, AN/ALQ-147(V)1 at wing stations 1 or 6.

²Determination of ground distance required to clear 50, 100, 200 foot obstacle.

³Field elevation Edwards AFB, California: 2302 feet MSL.

⁴Field elevation Alamosa, Colorado: 7535 feet.

⁵Acceleration and deceleration tests performed at target gas generator speed (N1) of 90, 85, 80, 75, and 70% at 1.2 times the dual-engine power OFF stall airspeed, and with bleed air on and off.

⁶Initial survey with LSSS installed was performed during engine ground run with a gradual build-up of power settings. The firewall temperature was monitored throughout the test program.

⁷Power settings: Starting at 200 shp up to either the maximum temperature limit as established by the airworthiness release or 1800 shp. The aircraft was tied down for the ground temperature survey.

flaps when used) were retracted at 25 feet above ground level and the pitch attitude was adjusted to achieve a shallow to moderate positive climb angle while accelerating to $V_{y_{se}}$. Test data are shown in figures 1 through 8, appendix E. A slightly greater distance (up to 500 feet) was required to become airborne with the flaps-up than with flaps-15. Time to achieve $V_{y_{se}}$ with flaps-up was approximately 3 seconds less than with flaps-15 at power settings greater than 900 shp. At power settings below 900 shp, time to achieve $V_{y_{se}}$ was the same. At all power settings, less distance was required to clear a 200-foot obstacle or to attain $V_{y_{se}}$ with flaps-up as compared to flaps-15. Flaps-15 takeoffs resulted in a loss of altitude when the flaps were retracted. This loss of altitude was more pronounced at the lower power settings. Figure 9 shows the temporary altitude loss when flaps were retracted. Flaps-up takeoffs did not result in a loss of altitude and were more comfortable to the pilot. The altitude loss upon flap retraction was quite disconcerting when using the flaps-15 takeoff technique at lower power. Use of the flaps-up takeoff procedure eliminates the additional engine failure emergency procedure of raising the flaps. The flaps-up procedure also eliminates the portion of the takeoff profile where the aircraft cannot accelerate because the flaps are down and the flaps cannot be retracted because the airspeed is below flaps-up V_{mc} . The flaps-up takeoff procedure should be incorporated into the operator's manual as an operational procedure.

Crosswind Takeoffs and Landings

8. Flaps-up crosswind takeoffs were conducted at light gross weight (15,400 pounds average). The drop tanks were empty and the AN/ALQ-147(V)1 was installed on wing station 1 in order to approximate the most critical all-stores configuration. A build-up was conducted by using 90 percent torque and a 60 degree, 15-knot right crosswind component. The second takeoff was conducted at 90 percent torque and a 90 degree 15 knot right crosswind component. For subsequent takeoffs, power was set at 23 percent torque, the brakes released and the target power of 100 percent torque was established prior to reaching 50 KIAS. Representative time histories are presented in figures 10 and 11. The aircraft attitude at flight idle power was approximately 2 degrees left wing low. Full right aileron was applied prior to starting the takeoff roll. The roll attitude was approximately 5 to 7 degrees left wing low after increasing power to 23 percent torque. The ailerons were sufficiently effective at 95 KIAS to level the roll attitude using full right aileron. Right aileron was reduced to keep the wings level with the aileron control being essentially centered at rotation speed of 104 KIAS with lift-off at 107 KIAS.

Nosewheel steering was effective and minimal pilot compensation (Handling Qualities Rating Scale (HQRS) 3) was required to maintain runway heading and keep the aircraft on the simulated runway centerline. Takeoffs were also performed with the flaps-15 where roll attitudes similar to the flaps-up takeoffs were observed. The ailerons became effective at approximately 70 KIAS instead of 95 KIAS. During one takeoff (flaps-up) an attempt was made to apply power to 46 percent torque prior to brake release to simulate a minimum run condition, however, the left strut was fully compressed at approximately 35 percent torque, and the power had to be reduced to alleviate the wing low condition. The following CAUTION should be placed in chapter 8 of the handbook.

CAUTION

Minimum run takeoff procedures (applying power to 46 percent torque prior to brake release) should not be attempted with right crosswinds near the 15 knot, 90 degree component limit. Under these conditions the left strut may become fully compressed.

Flaps-45 and flaps-up landings were conducted with 15 knot 90 degree crosswind components uneventfully. The most critical portion of all takeoff and landing operations was during initial power application at the beginning of the takeoff roll. Flaps-up procedures should be incorporated into operational use with the existing wind limitations shown in the operator's manual. It is particularly important that the gear struts be serviced with the proper amount of hydraulic fluid and nitrogen or air to prevent excessive compression of the strut during the initial portion of the takeoff roll.

GROUND MINIMUM CONTROL SPEED (V_{mcg})

9. V_{mcg} was determined by accelerating with increasing asymmetric power until an airspeed was reached where control was just sufficient to maintain heading at 100 percent torque. This V_{mcg} was verified by accelerating with both engines to a speed above V_{mcg} , cutting power to the left (critical) engine, delaying recovery action for 1 second to simulate pilot reaction time, then reducing power on the operating engine and moving the prop lever on the other engine to the minimum propeller speed position to simulate operation of the autofeather system. During the verification procedure, the pilot was able to simulate the failure 5 KIAS

lower than the V_{mcg} number determined by accelerating with asymmetric power. V_{mcg} time histories for heavy weight are presented in figures 12 through 15. For all engine failure conditions, including failure immediately after start of the takeoff roll with full power applied, the aircraft was controllable with immediate pilot reaction. Deviation from centerline exceeded 30 feet when the pilot did not reduce power immediately, however, the aircraft could be controlled so that it would not depart the runway. The aircraft was controlled well within 30 feet of centerline with moderate pilot compensation (HQRS 4) at the V_{mcg} 's presented. At 100 percent torque, the aircraft continued to accelerate after a simulated single-engine failure. The nose-wheel was checked for excessive wear after each V_{mcg} test. The nosewheel power steering was adjusted per maintenance procedure to provide 38 degrees of nosewheel travel statically on the ground with full pedal deflection. Although essentially full rudder had been used, there was very little evidence of nose tire side scuffing, therefore, the nosewheel must have been very close to tracking the aircraft ground path. It may be possible for the hydraulic pressure adjustment on the wheel steering to be improperly adjusted while following prescribed maintenance procedures. This could cause more nosewheel steering authority at higher groundspeed, possibly rolling the nose tire off the rim. The V_{mcg} characteristics of the OV-1D with YT53-L-704 engine are satisfactory.

ACCELERATE-STOP DISTANCE

10. Accelerate-stop distance was determined at the conditions shown in table 1. Initial power was set at 46 percent torque, the brakes released and power increased to 100 percent torque. The aircraft was accelerated to rotation speed ($1.1 V_{mc}$ minus 3 KIAS), the number one engine power lever was reduced to ground idle and after a one second delay the power was reduced on the operating engine and the failed engine propeller was placed at minimum rpm to simulate operation of the autofeather system. Braking only was used during the first accelerate-stop test point. The pilot was unable to bring the aircraft to a stop within the distance shown in the handbook. The brake linings and pucks became excessively hot and were ineffective by the time the airspeed had decreased to approximately 60 KIAS. Reverse thrust had to be used to bring the aircraft to a stop from approximately 35 KIAS. The brake linings and pucks were a bright red with molten puck material abrading from the brakes during the final portion of the run. The brake disc temperature approximately two minutes after stopping the aircraft was 780°F. The complete brake assembly had to be replaced. Photographs of

the brake disks and the remaining portions of the pucks are shown in photos 1 through 3, appendix E. A procedure was developed to use aerodynamic braking to assist in bringing the aircraft to a stop. Deceleration tests were conducted at the conditions shown in table 1. The optimum deceleration method was to extend the speed brakes, lower the flaps to 45 degrees, and hold the nose as high as possible without scraping the tiedown skid until elevator effectiveness was lost. Once the nosewheel touched down (60 to 65 KIAS) wheel braking was initiated with constantly increasing pressure until the aircraft came to a stop. Wheel braking was effective in bringing the aircraft to a stop from 60 to 65 KIAS, however, intermittent brake fade and brake-wheel chatter made it impossible for the pilot to determine if a wheel had locked. Brake chatter also occurred during brake applications during normal taxi. The tendency for the wheel brakes to chatter during taxi and landing roll brake application is a shortcoming. During these evaluations, one tire was blown and another one flat spotted. Pictures of the skid marks are shown in photos 4 and 5. A comparison of accelerate-stop distances resulting from the tests are presented in table 1, appendix F. Time histories of the accelerate-stop tests are presented in figures 16 through 21. The accelerate-stop distance was not significantly less for lighter weights since wheel braking could not be as heavily used on the light weights without locking the wheels. The accelerate-stop distances presented in the OV/RV-1D handbook are optimistic at light gross weights. The accelerate-stop distance chart in the handbook should be revised to reflect the results of this test. The accelerate-stop distances for the flaps-up configuration was approximately 500 feet greater than for flaps-15 configuration. The ineffective wheel brake system of the OV-1D is a deficiency. An anti-skid system should be incorporated to prevent inadvertent wheel lockup, and help decrease stop distance. The aerodynamic braking procedure should be incorporated into operational unit training and required by the Aircrew Training Manual (ref 6). The procedure should be trained by accelerating to some speed above 65 KIAS but below rotation speed, an engine failure simulated by the instructor pilot reducing a power lever to flight idle. The pilot should immediately reduce both power levers to ground idle, extend the speed brake, select flaps to 45 degrees, and hold the nose high until elevator effectiveness is lost. Once the nosewheel contacts the ground dual-engine reverse can be used to bring the aircraft to a stop. An oral discussion of using wheel braking vice dual-engine reverse in an actual engine failure situation should be presented.

ENGINE RESPONSE CHARACTERISTICS

11. Engine shutdown, restart, acceleration and deceleration tests were conducted at the conditions shown in table 1. Engine restart attempts were unsuccessful at 20,000 feet, but were successful at 19,000 feet. At 20,000 feet, there was no light-off, therefore, restarts were not attempted at 25,000 feet. At 19,000 feet, a normal restart was accomplished with no problems noted. The engine restart characteristics of the OV-1D with YT53-L-704 engines are satisfactory. If YT53-L-704 engines are installed on operational aircraft, the discussion of engine restart procedures in TM 55-1510-213-10, paragraph 9-5 should be changed to indicate that engine restart may not be possible above 19,000 feet pressure altitude. The YT53-L-704 engine restart characteristics using JP-5 and/or JP-8 should be evaluated.

12. Engine acceleration and deceleration tests were conducted at the conditions in table 1. The power was stabilized at the maximum allowable/available. The power lever was then rapidly reduced to flight idle. As the gas generator speed (N1) decreased through a target speed of 90 percent, the engine was rapidly advanced to the maximum allowable/available power. This process was repeated for target N1 values of 85, 80, 75, and 70 percent. Representative time histories of engine acceleration/deceleration characteristics are presented in figures 22 and 23. There were no compressor stalls or tendency to overspeed N1, or exceed measured gas temperature (MGT), or torque limits. Minor overshoots of propeller speed did occur, but propeller speed limits were not reached. Both single and dual-engine power changes were evaluated. Acceleration tests with bleed air (air conditioning) ON resulted in approximately 50 degree centigrade greater MGT. MGT limits were not reached and no problems were noted. The engine response characteristics of the OV-1D with YT53-L-704 engines are satisfactory.

ENGINE FIREWALL TEMPERATURE SURVEY

13. Engine firewall temperature surveys were conducted at the conditions listed in table 1 with and without LSSS installed. Firewall temperatures were observed and manually recorded at a range of stabilized power settings by starting at ground idle going to flight idle, and then increasing torque settings in 10 percent increments up to the maximum firewall temperature limit or maximum allowable power whichever occurred first. A tabular listing of temperatures is presented in tables 2 and 3. Table 2 presents data for the ground run engine temperature survey without LSSS installed. Table 3 presents data for ground run and in-flight

engine temperature surveys with LSSS installed. There were no temperature problems with the standard exhaust stacks installed. The maximum temperature recorded was 131 degrees centigrade. Without LSSS installed, the hottest firewall position was the 12 o'clock position. During the LSSS installed ground run survey power settings above 70 percent torque exceeded the temperature limits of 315 degrees centigrade at the 6 o'clock position on the firewall. Temperatures in-flight at 90 KIAS with engine torque above 60 percent, exceeded the 315 degree centigrade limit at the 6 o'clock position on the firewall. At 198 KIAS, power was set at 112 percent torque, maximum power for test day conditions. The maximum temperature was 299 degrees centigrade at 198 KIAS. The engine firewall temperatures at power levels above approximately 60 percent torque with the LSSS installed are excessive and unsatisfactory. The LSSS should be modified to prevent excessive firewall temperatures prior to use with T53-L-704 engines. A firewall temperature survey should be conducted on an OV-1D with T53-L-701 engines with LSSS installed to determine if the temperature exceeds the 315 degree centigrade limits at high power settings.

HUMAN FACTORS

14. The cockpit noise levels during takeoff and climb power settings preclude intelligible communication and are a deficiency. This deficiency was previously noted during USAAEFA Project No. 85-17. An ANR system manufactured by BOSE under contract to the Air Force was evaluated during this program. The ANR did reduce the noise level significantly at lower power settings (up to 60 percent torque) but was less effective at high power/propeller speed settings. The ANR has potential for reducing the excessive noise level in the OV/RV-1D aircraft, but must be redesigned to be effective at the high decibel level encountered in the OV/RV-1D aircraft. For a description of the ANR operation, see appendix B.

CONCLUSIONS

GENERAL

15. The following conclusions were reached based on the flaps-up takeoff performance evaluation:

a. The distance to lift-off was slightly greater (up to 500 feet) using the flaps-up than when using flaps-15 settings (para 7).

b. The distance to $V_{y_{se}}$ was slightly less using the flaps-up setting than when using flaps-15 settings (para 7).

c. The time to $V_{y_{se}}$ from lift-off was reduced by approximately 3 seconds using the flaps-up setting as opposed to flaps-15 (para 7).

d. Flaps-up takeoffs eliminated the hazardous sinking caused by retracting the flaps (para 7).

e. The flaps-up takeoff procedure eliminated the additional emergency procedure of raising the flaps required to achieve optimum climb performance (para 7).

f. Flaps-up takeoffs eliminated the portion of the takeoff profile where the aircraft cannot accelerate single-engine because the flaps are down, and the flaps cannot be raised because air-speed is below flaps-up V_{mc} (para 7).

g. Flaps-up procedures can use existing wind limitations shown in the operator's manual (para 8).

h. The V_{mcg} characteristics of the OV-1D with YT-53-L-704 engines were satisfactory (para 9).

i. YT53-L-704 engine restart attempts were unsuccessful above 19,000 feet pressure altitude (para 12).

j. YT53-L-704 engine throttle response characteristics were satisfactory up to and including 25,000 feet pressure altitude (para 12).

k. Minimum run takeoff procedures (applying power to 46 percent torque) with right crosswinds near the 15 knot, 90 degree component limit resulted in excessive compression of the strut as power is applied above approximately 35 percent of torque (para 8).

1. The ANR has the potential of reducing the excessive noise level of the OV-1D cockpit if redesigned to be effective at the OV/RV-1D operational cockpit noise level (para 14).

DEFICIENCIES

16. The following deficiencies were noted:

- a. The ineffective wheel brake system of the OV-1D (para 10).
- b. The excessive cockpit noise level with takeoff or climb power settings (para 14).
- c. Excessive firewall temperatures both on the ground and in slow flight during operation of the YT53-L-704 engine, above 60 percent torque with LSSS installed (para 13).

SHORTCOMING

17. The tendency for the wheel brakes to chatter during taxi and landing roll brake application is a shortcoming (para 11).

RECOMMENDATIONS

18. The following recommendations are made:

a. Incorporate flaps-up takeoff procedures into the OV/RV-1D handbook and Aircrew Training Manual with the existing wind limitations shown in the operator's manual (paras 7 and 8).

b. Incorporate training for engine failure during takeoff (sufficient runway) procedures using aerodynamic braking to include speed brakes and flaps set to 45 degrees into the handbook and Aircrew Training Manual (para 10).

c. Install an anti-skid wheel braking system on the OV-1D (para 10).

d. The following CAUTION should be placed in chapter 8 of the Handbook (para 8).

CAUTION

Minimum run takeoff procedures (applying power to 46 percent torque prior to brake release) should not be attempted with right crosswinds near the 15 knot, 90 degree component limit. Under these conditions, the left strut may become fully compressed.

e. The ANR should be redesigned to be effective at the decibel levels encountered in the OV/RV-1D cockpit. Further evaluation, after redesign, should be conducted (para 14).

f. Correct the handbook accelerate-stop distance chart (para 10).

g. If YT53-L-704 engines are installed on operational aircraft, the discussion of engine restart procedures in TM 55-1510-213-10, paragraph 9-5 should be changed to indicate that engine restart may not be possible above 19,000 feet pressure altitude (para 11).

h. The LSSS should be modified to prevent excessive firewall temperatures prior to use with T53-L-704 engines (para 13).

i. A firewall temperature survey with T53-L-701 engines and LSSS installed should be conducted (para 13).

APPENDIX A. REFERENCES

1. Letter, AVSCOM, AMSAV-8, 11 August 1986, subject: Flaps-up Takeoff Performance Tests of the OV-1D Airplane with the YT53-L-704 Engine Installed. (Test Request)
2. Technical Manual, TM 55-1510-213-10, *Operator's Manual, OV/RV-1D Aircraft*, 4 August 1978 through change 11, 9 October 1986.
3. Letter, AVSCOM, AMSAV-E, 17 September 1986, subject: Airworthiness Release, OV-1D(C) SN 62-5867, with the YT53-L-704 Engines Installed.
4. Flight Test Manual, Naval Air Test Center, FTM No. 103, *Fixed Wing Stability and Control*, 1 January 1975.
5. Flight Test Manual, Naval Air Test Center, FTM No. 104, *Fixed Wing Performance*, July 1977.
6. Field Circular, FC 1-217, Aircrew Training Manual, *Surveillance Airplane, OV-1*, 30 December 1984.

APPENDIX B. DESCRIPTION

DESCRIPTION

1. The OV-1D(C) test aircraft S/N 62-5867 (photos 1 through 4) is a two-place, twin-engine turboprop aircraft featuring a mid-wing, triple vertical stabilizer, and a tricycle landing gear. Seven external store stations, including the fuselage are used to carry a variety of surveillance pods and/or fuel tanks. For this program, the aircraft was tested with two 150 gallon drop tanks and Side Looking Airborne Radar boom installed, and with the 147(V1) infrared system on wing station 6 except for crosswind limits tests (STORES configuration). The Louvered Scarfed Shroud Suppressor was not installed except during the engine nacelle temperature survey. The major modifications to the test aircraft include the installation of Lycoming YT53-L-704 engines rated at 1800 shaft horsepower sea-level standard day conditions. For a description of the YT53-L-704 engines (see final report U.S. Army Aviation Engineering Flight Activity Project No. 85-17, dated November 1986).

ACTIVE NOISE REDUCTION SYSTEM

2. Current headsets provide passive hearing protection by acting as a barrier against noise. Active Noise Reduction (ANR) is a technology that uses micro-electronics to actively cancel low and mid-frequency noise inside the earcups by emitting a signal that is 180 degrees out of phase with the noise signal. The ANR system consists of standard size earcups, cordage, and a box (6" x 3" x 2", 1.4 lb) that fits into the survival vest. The system plugs directly into a standard aircraft intercom system and provides a two pin plug for the oxygen mask microphone. The box houses the electronics and the power source which is two 9V batteries. A switch on the box allows the user to select "ON", "BYPASS", or "OFF". Normally, the user will select "ON". In this mode, ANR is functioning. If the batteries fail or if the user decides to cancel ANR, "BYPASS" is selected. Switched to "BYPASS", radio capability and passive noise attenuation are maintained. In the "OFF" mode ANR is canceled, radio transmission is maintained, but radio reception is lost.

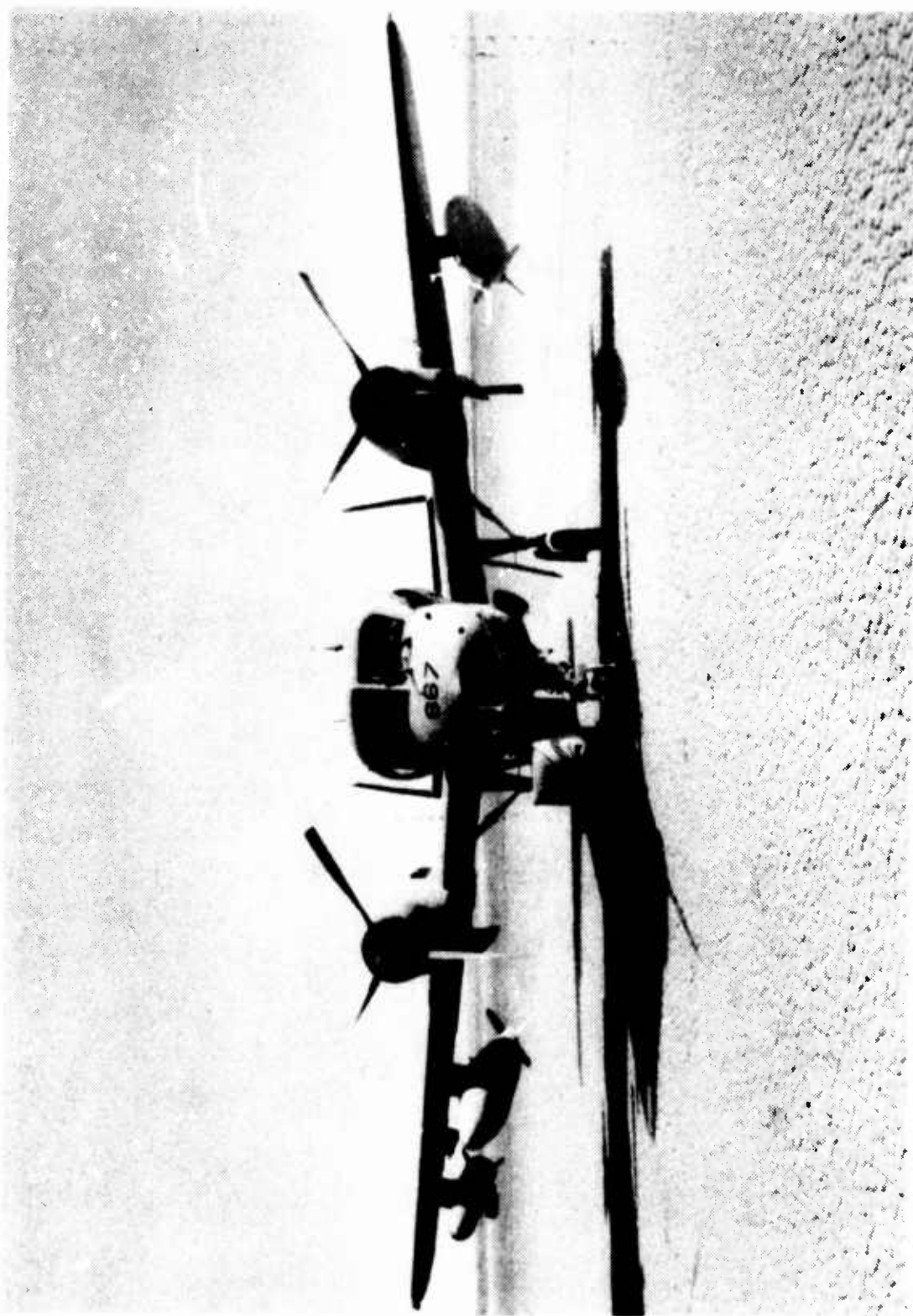


Photo 1. Front View of Stores Configuration

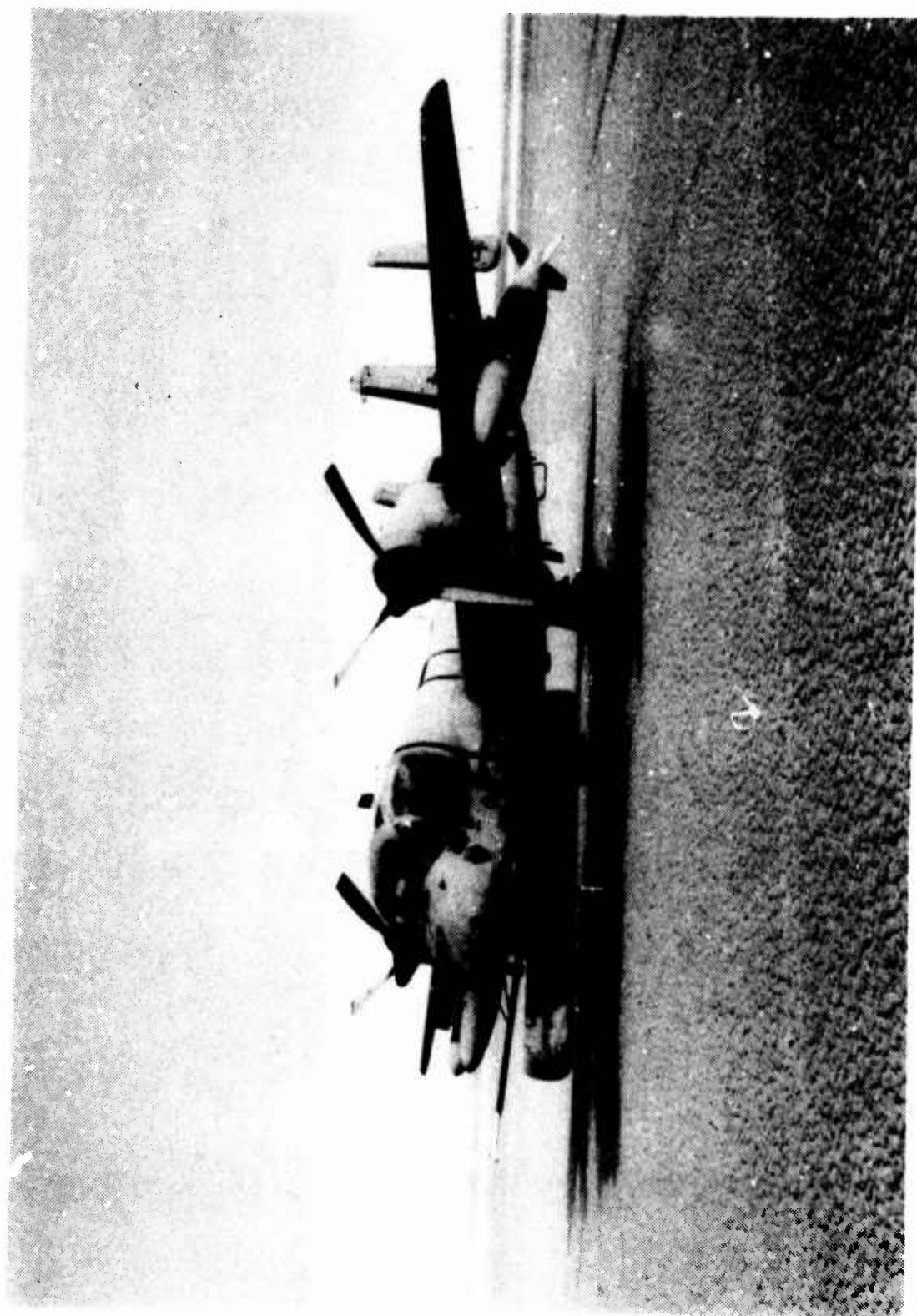


Photo 2. Left Front Quartering View

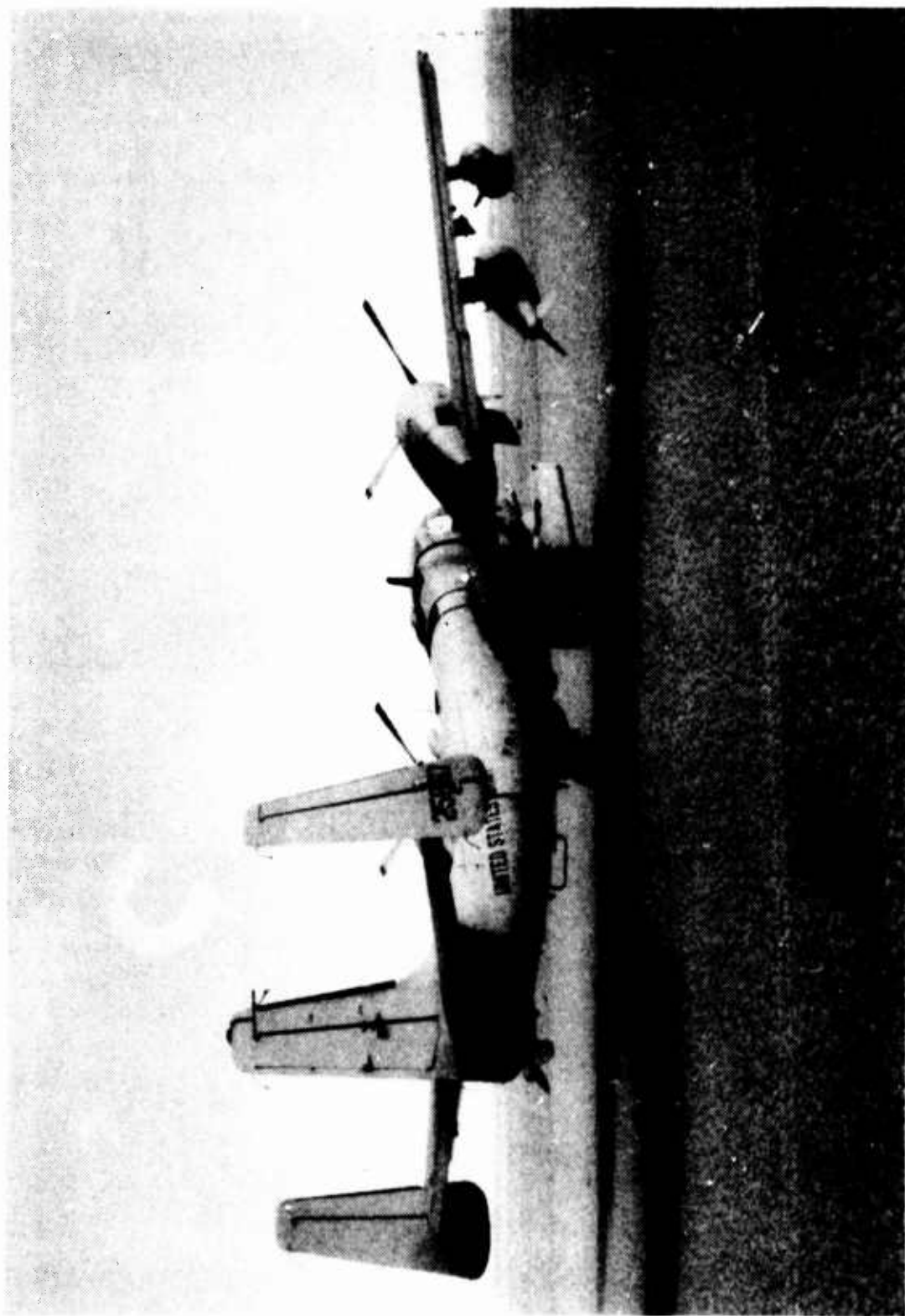


Photo 3. Right Rear Quartering View

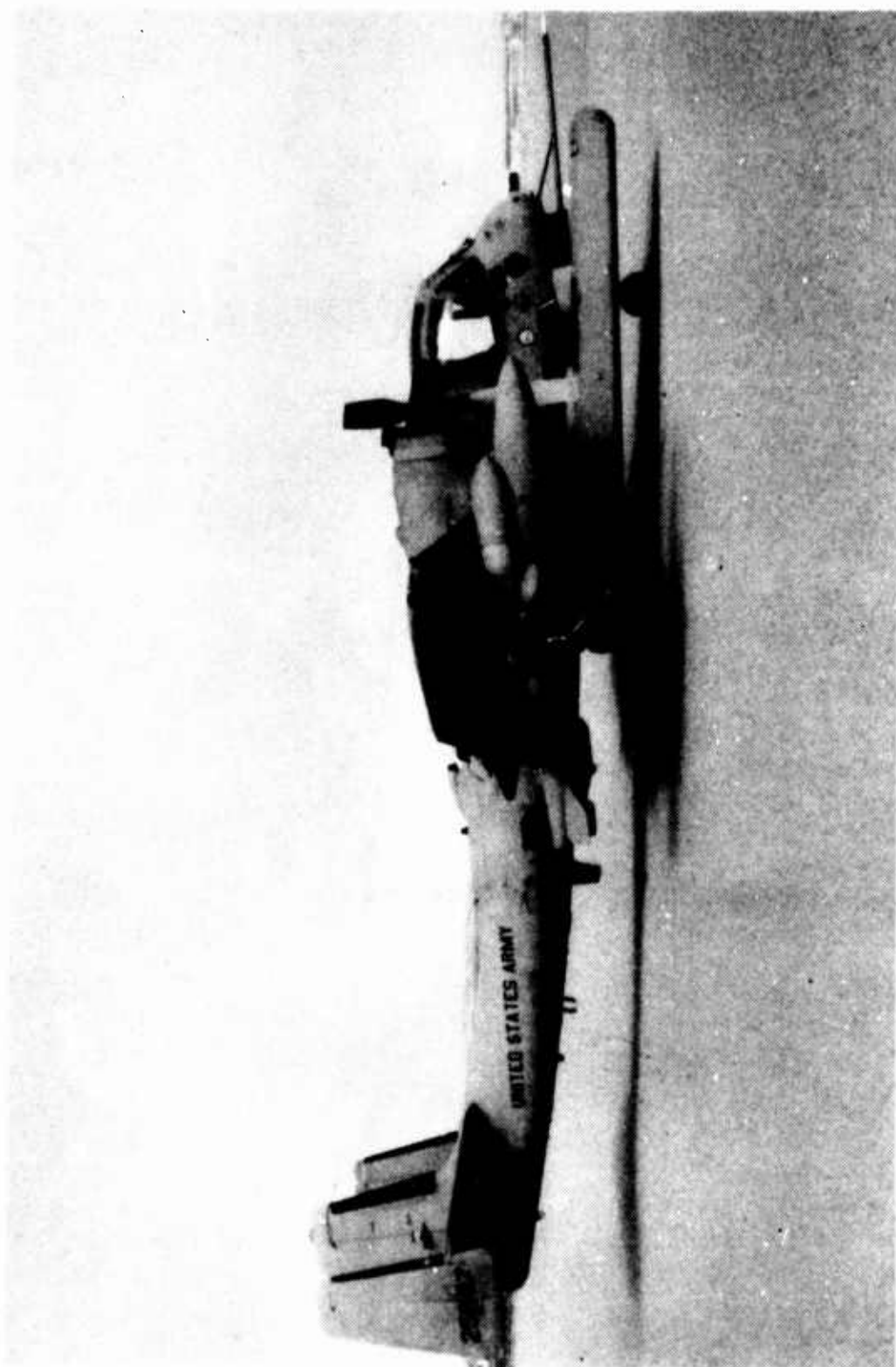


Photo 4. Right View

APPENDIX C. INSTRUMENTATION

1. An airborne data acquisition system was installed by the US Army Aviation Engineering Flight Activity. The system included transducers, potentiometers, wiring, signal conditioning, pulse code modulation encoding, magnetic tape recording of all parameters, cockpit displays of selected parameters, and the capability to telemeter the data to a ground station.
2. An airspeed boom extending forward from the nose of the aircraft was installed. This boom incorporated angle-of-attack and angle-of-sideslip sensors, and a swiveling pitot-static tube.
3. A Del Norte Technology Incorporation (DNTI) range measuring system was used to determine horizontal distance for takeoff, accelerate-stop, and deceleration tests. The DNTI system consists of the Model 562 Digital Distance Measuring Unit (DDMU) and two remote Model 261 transponders. The DDMU has a microprocessor and a master transponder which operates on a microwave system in the X-band frequency range of 12.4 gigahertz. The DDMU requires 24 volts direct current (vdc). The total weight of the DNTI system installed on the aircraft was 107 pounds which included the DDMU, master transponder, antenna, interface, and cables. The remote transponders are direct line of sight equipment located outside the aircraft mounted on tripods 300 feet behind and 500 feet to the side of the starting point (one for each side of the runway centerline). The remote transponders require 12 vdc, measures 9.5 inches x 4.0 inches x 8.0 inches and weighs 8.5 pounds. Basically, distance is calculated by measuring the time it takes for the master transponder to receive a signal from the remote transponders. The master transponder starts a timer while simultaneously sending a microwave pulse to the remote transponders. When the remote transponder receives a pulse, a return pulse is immediately sent back to the master transponder which stops the timer when the return pulse is received. The DDMU then uses time and the speed of light to calculate distance which is recorded on the aircraft magnetic tape system.
4. The parameters measured and recorded for all phases were:

<u>Parameter</u>	<u>Cockpit Indicator</u>
Aircraft attitudes	
Pitch	--
Roll	--
heading	--
Airspeed	
Boom	Yes
Ship	Yes

Altitude	
Boom	Yes
Ship	Yes
Ambient total air temperature	Yes
Boom angle of attack	Yes
Boom angle of sideslip	Yes
Aircraft angular rates	
Pitch	--
Roll	--
Yaw	--
CG normal acceleration	Yes
Control positions	
Longitudinal	--
Lateral	--
Directional	--
Left throttle	--
Right throttle	--
Control force	
Left pedal	--
Right pedal	--
Control surface positions	
Elevator	--
Left outboard aileron	--
Left rudder	--
Right rudder	--
Center rudder	--
Del Norte Slant Range	
Transponder #1	--
Transponder #2	--
Engine	
Fuel flow, left	Yes (ship)
Fuel flow, right	Yes (ship)
Fuel totalizer, left	Yes
Fuel totalizer, right	Yes
Gas generator speed, left	Yes (ship)
Gas generator speed, right	Yes (ship)
Measured gas temperature, left	Yes (ship)
Measured gas temperature, right	Yes (ship)
Propeller speed, left	Yes (ship)
Propeller speed, right	Yes (ship)
Torque, left	Yes (ship)
Torque, right	Yes (ship)
Event markers	
Pilot	--
Recorder ON/OFF	--
Record number	Yes
Time	Yes
Voice Channel	--

APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

GENERAL

1. This appendix contains a description of the test techniques used for evaluating performance, handling qualities, engine response characteristics, and engine firewall temperature survey.

TAKEOFF PERFORMANCE

2. For all takeoff tests, the aircraft was positioned on a predetermined surveyed point on the approach end of the runway. Handbook takeoff trim settings were used. Pressure altitude, outside air temperature (OAT), fuel used and fuel remaining were hand recorded. The data recording system was turned on, power was set to 46 percent torque, the brakes released and power then adjusted to the desired power setting for the test run. The aircraft was accelerated to rotation speed using the ship's airspeed indicator as the airspeed reference. At rotation speed a positive aft longitudinal control input was made so that lift-off at the target speed could be attained. Lift-off speed was 1.1 times the velocity for minimum control (V_{mc}) with V_{mc} numbers being determined from V_{mc} /stall tests conducted during U.S. Army Aviation Engineering Flight Activity (AEFA) Projects Nos. 85-16 and 85-17. A shallow to moderate positive climb angle, depending on excess power, was maintained while accelerating to single-engine best rate of climb speed (V_{yse}). The gear and flaps (for flaps-15 takeoffs) were retracted at 25 feet above ground level (AGL) as measured by the radar altimeter. The lift-off point was determined by a combination of information from the Del Norte system (for runway distance), radar altimeter, center of gravity normal acceleration trace smoothing, and main gear strut switch extension indications recorded on the aircraft data tape. V_{yse} , when attained, was held throughout the climb through 200 feet AGL. Distance and time was determined using time history data.

3. The total horizontal distance required to clear an obstacle (S_T) was composed of the ground roll distances (S_{g_s}) and the airborne horizontal distance (S_{a_s}).

$$S_T = S_{g_s} + S_{a_s}$$

4. Values of ground roll distance (S_{g_w}) and airborne horizontal distance (S_{a_w}) were obtained using the Del Norte range measuring system, and data were corrected to no wind conditions, standard gross weight and standard day atmospheric conditions. Runway slope corrections were not applied. Horizontal distance was corrected for wind using the following equation:

For the ground phase:

$$Sg_t = Sg_w \left(1 + \frac{V_w}{V_{TO_w}} \right)^{1.85}$$

Where:

Sg_t = Ground roll corrected for wind (ft)

Sg_w = Ground roll with wind (ft)

V_w = Wind velocity component in direction of takeoff (ft/sec)

V_{TO_w} = Takeoff ground speed (ft/sec)

For the air phase:

$$Sa_t = Sa_w + V_w t$$

Where:

Sa_t = Horizontal air distance corrected for wind to clear obstacle (ft)

Sa_w = Horizontal air distance with wind to clear obstacle (ft)

t = Time from liftoff to clear obstacle (sec)

5. The horizontal distance was next corrected to standard values of weight, and density altitude by the relationship:

For the ground phase:

$$Sg_s = Sg_t \left(\frac{\frac{W_s}{W_t} \frac{\sigma_t}{\sigma_s}}{\frac{2gSg_t F_n}{(V_{TO_w})^2} \left(\frac{1}{W_s} - \frac{1}{W_t} \right) + 1} \right)$$

Where:

Sg_s = Ground roll distance corrected for wind, standard day, and weight (ft)

W_s = Standard gross weight (lb)
 W_t = Test gross weight (lb)
 σ_t = Test day density ratio
 σ_s = Standard day density ratio
 g = Accelerations due to gravity (32.1704 ft./sec²)
 F_n = Test propeller thrust (lb)

For the air phase:

$$S_{a_s} = S_{a_t} \left(\frac{\left(\frac{W_s}{W_t} \frac{\sigma_t}{\sigma_s} \right) \left(\frac{V_{ht}^2 - V_{TO}^2}{2g} \right) + \text{height}}{\left(\frac{V_{ht}^2 - V_{TO}^2}{2g} \right) + \text{height} + S_{a_t} F_n \left(\frac{1}{W_s} - \frac{1}{W_t} \right)} \right)$$

Where:

S_{a_s} = Horizontal air distance from liftoff to obstacle height corrected for wind, standard day and gross weight (ft)
 V_{ht} = True airspeed at the obstacle height (ft/sec)
 Height = Obstacle height (ft)

DECELERATIONS

6. Deceleration evaluations were conducted by accelerating the aircraft to approximately 110 knots, reduce power to ground idle and allow the aircraft to decelerate to a low (approximately 40 knots indicated airspeed (KIAS)) airspeed. Deceleration data was used to determine the best procedure for performing accelerate-stop tests and the data was provided to the U.S. Army Aviation Systems Command to be used to determine OV/RV-1D ground deceleration characteristics.

ACCELERATE-STOP DISTANCE

7. Accelerate-stop tests were conducted by positioning the aircraft on a predetermined, surveyed starting point on the approach end of the runway. Handbook takeoff trim settings were used. Pressure altitude, OAT, fuel used and fuel remaining were hand recorded. The data recording system was turned on, torque was set at 46 percent, the brakes released, torque was set to

the desired power setting, and the aircraft accelerated to rotation speed. At rotation speed failure of the number one engine was simulated by the pilot reducing the throttle to ground idle. The pilot delayed for one second, then reduced the number two engine to ground idle while the right seat pilot reduced the number one propeller lever to minimum rpm to simulate autofeather. During initial tests, only wheel braking was used, however, the brakes overheated and became ineffective. Subsequent aerodynamic deceleration tests using combinations of speed brakes and flap settings indicated that immediate activation of speed brakes, lowering of the flaps to 45 degrees and applying aft longitudinal control input to achieve a nose high attitude provided the most effective deceleration. This test procedure was used to generate the resulting accelerate-stop distance data for this evaluation. The nose high aerodynamic braking attitude was held until the elevator control became ineffective at 60 to 65 KIAS (the nose wheel could no longer be held off of the ground). Wheel braking was then initiated to bring the aircraft to a stop. After the aircraft was stopped, the propellers were feathered so that the brakes could be released to prevent welding of the pucks to the disks. The nose wheel was then chocked with oversized chocks, the propeller unfeathered, the throttles set at flight idle to provide cooling air flow over the main gear wheels and brake components. The maintenance crew took temperature readings of the brake component area using a thermocouple attached to the end of a four foot rod with remote temperature readout. This procedure provided a relatively safe method of recording wheel temperature. Conversations with Goodyear Tire engineers indicated that the aircraft should not be moved or subsequent runs attempted until wheel component temperature had decreased below 150°C. Once the temperature had decreased below 150°C the maintenance crew examined the tires for deterioration and flat spots and the brake components for wear. When the aircraft was brought to a stop, the distance was measured from known surveyed points on the runway as a backup to the Del Norte system. Selected parameters including the Del Norte distance were monitored by an engineer via telemetry to verify that the Del Norte system was providing time history data during the actual tests.

SINGLE-ENGINE MINIMUM GROUND CONTROL SPEED

8. Single-engine minimum ground control speed (V_{mcg}) tests were conducted by positioning the aircraft on the runway, (not at a predetermined spot) recording pressure altitude, OAT, fuel used, and fuel remaining. The aircraft was then accelerated with increasing power using the number two engine only, to the speed

at which the aircraft could be controlled directionally with rudder pedals and nosewheel steering using 100 percent torque on the number two engine. When the desired power setting was reached, the speed was noted. This speed was the expected V_{mcg} . The aircraft was then repositioned at the approach end of the runway, data recorded, and the aircraft accelerated dual-engine to speeds starting 10 KIAS above the expected V_{mcg} determined using the above procedure. When the desired speed was reached, the number one engine was failed by reducing the power lever to ground idle, delaying one second then reducing the number one propeller control to the minimum rpm position to simulate autofeather. Subsequent runs were completed decreasing the simulated engine failure speed in 5 KIAS increments. The maximum allowable deviation from centerline was 30 feet. The nose tire was checked for excessive wear after each test run.

CROSSWIND TAKEOFF AND LANDINGS

9. Crosswind takeoffs and landings were conducted at the lightest feasible gross weight and with the AN/ALQ-147(V)1 positioned on wing station one to provide the most critical configuration with power applied (due to torque effect). The lakebed compass rose was used so that virtually any direction could be used for the correct crosswind component. A wind station provided continuous wind velocity and direction readouts. The main gear struts were serviced with the proper amount of fluid and dry air or nitrogen prior to commencing these tests to prevent excessive strut compression. At the beginning of the run, with the aircraft in position for takeoff, the pressure altitude, OAT, fuel used, and fuel remaining were hand recorded. The data recording system was activated, the power set to 23 percent torque, and the brakes released. Takeoff power was applied prior to attaining 50 KIAS. Nosewheel steering was used in maintaining ground track. Full aileron into the wind was maintained until the ailerons were sufficiently effective to level the wings laterally. At that point, sufficient aileron was used to maintain a wings level attitude. Crosswind landings were evaluated by using the crab technique down to 50 feet AGL, then transitioning to an upwind wing low slip with a slight amount of additional power on the upwind engine to aid in maintaining directional control.

ENGINE RESPONSE CHARACTERISTICS

10. Engine response characteristics tests were conducted by reducing the throttle to flight idle from maximum power, then

jam accelerating to maximum power as the compressor rpm decreased through target speeds of 90, 85, 80, and 75 percent, with and without bleed air systems operating. Normal handbook engine shutdown and restart procedures were used for the restart evaluations.

ENGINE FIREWALL TEMPERATURE SURVEY

11. The number two engine firewall was instrumented with thermocouples at the 12, 3, 6 and 9 o'clock positions (measured clockwise viewed from the rear). A cockpit digital readout with selectable position control was provided. All firewall temperatures were hand recorded. Surveys were completed without the Louvered Scarfed Shroud Suppressor (LSSS) system installed in-flight and during ground engine runs, and with the LSSS system installed during ground engine runs and in-flight at slowflight (approximately 90 KIAS) and at a cruise flight airspeed (approximately 198 KIAS). Power settings were increased in 10 percent increments from minimum power to the maximum allowable power or the firewall temperature of 315°C whichever occurred first. Power was then reduced in 10 percent increments to minimum power with recordings made both on the increase and decrease after allowing the power to stabilize at the desired settings for 2 minutes.

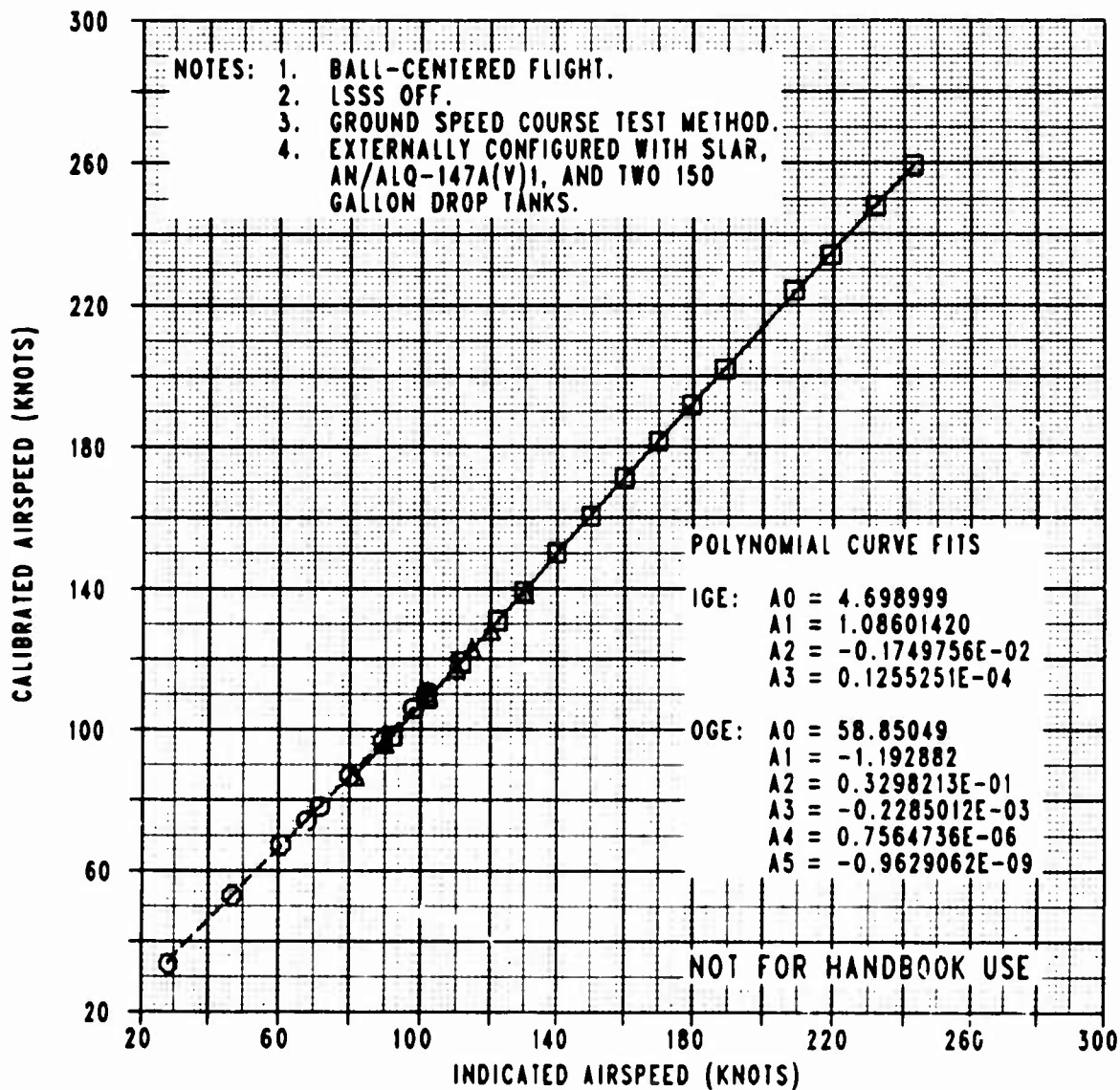
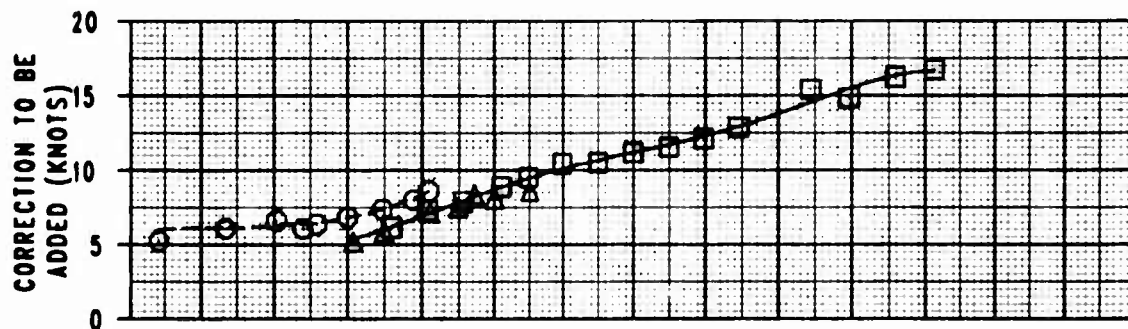
AIRSPEED CALIBRATION

12. The test boom pitot-static system was calibrated using the ground speed course method in in-ground effect (IGE) and in-flight. The IGE test involved taxiing the test aircraft on the runway at a constant indicated airspeed on reciprocal headings. Time and distance from the Del Norte Technology Incorporation range measuring system was used to calculate true airspeed. For the in-flight test, the test aircraft was flown over a measured, straight course marked on the ground. The aircraft was flown at constant indicated airspeeds for two passes over the course on reciprocal headings. True airspeed was calculated from the time and distance flown. Calibrated airspeed, for both tests, was calculated from the average true airspeed and using the test pressure altitude and temperature. The boom system airspeed calibration data is presented in figure A.

13. Prior to beginning flight testing, a weight and balance determination was conducted on the aircraft using calibrated scales.

FIGURE A
BOOM SYSTEM AIRSPEED CALIBRATION
OV-10 USA S/N 62-5867

SYM	GROSS WEIGHT (LB)	LONG. CG LOCATION (FS)	PRESSURE ALTITUDE (FT)	OAT (DEG C)	PROP SPEED (RPM)	FLAPS POSN (DEG)	GROUND EFFECT
○	17,840	160.6 (MID)	2070	1.5	1244	0	IN
△	15,080	158.3 (MID)	2470	25.5	1575	15	OUT
□	15,900	158.6 (MID)	2310	20.0	1600	0	OUT



DEFINITIONS

14. Results were categorized as deficiencies or shortcomings in accordance with the following definitions.

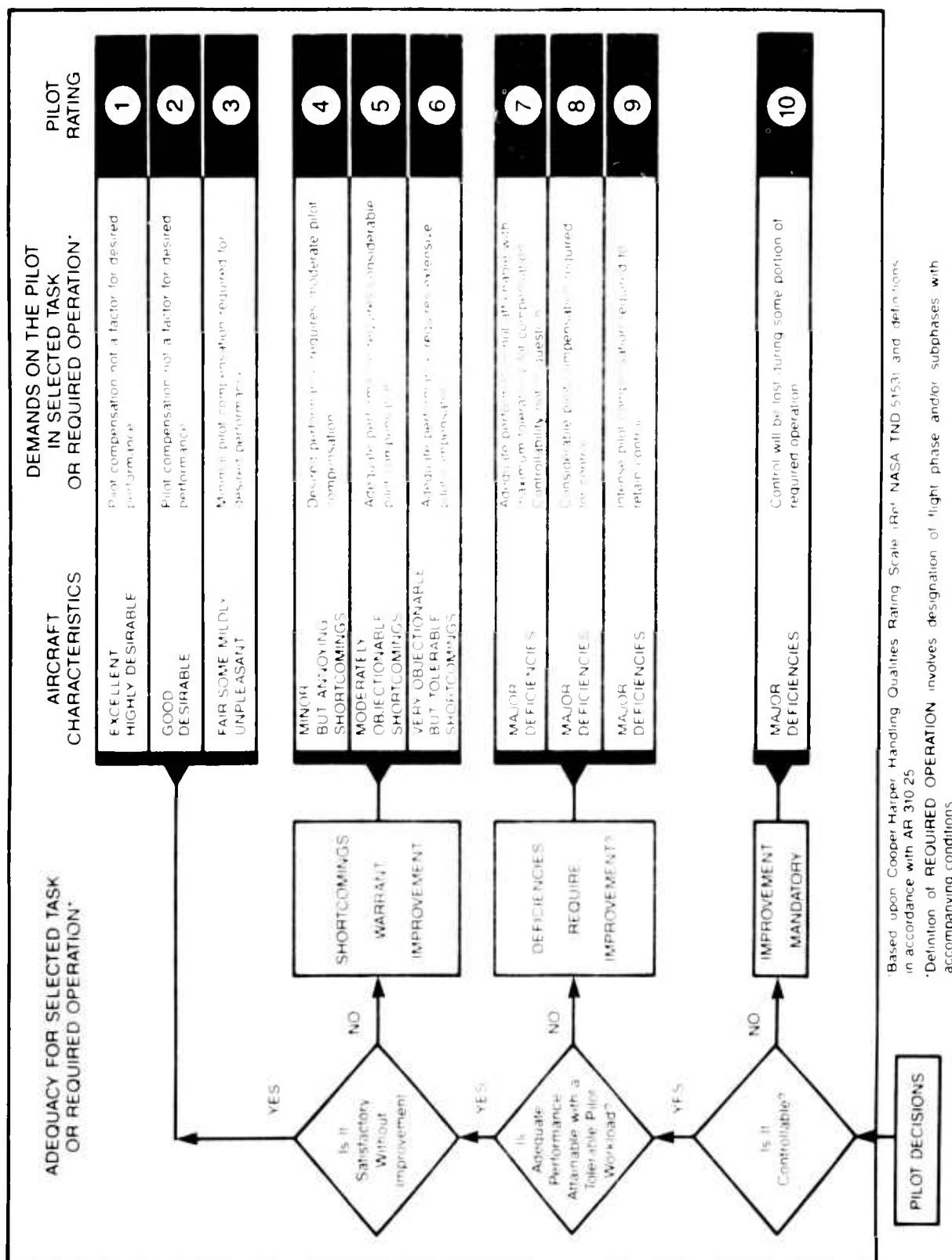
Deficiency

15. A defect or malfunction discovered during the life cycle of an item of equipment that constitutes a safety hazard to personnel; will result in serious damage to the equipment if operation is continued, or indicates improper design or other cause of failure of an item or part, which seriously impairs the equipment's operational capability.

Shortcoming

16. An imperfection or malfunction occurring during the life cycle of equipment which must be reported and which should be corrected to increase efficiency and to render the equipment completely serviceable. It will not cause an immediate breakdown, jeopardize safe operation, or materially reduce the usability of the material or end product.

17. A Handling Qualities Rating Scale was used to augment pilot comments relative to handling qualities. This scale is presented in figure B.



*Based upon Cooper-Harper Handling Qualities Rating Scale (Ref. NASA TN D 5153) and definitions in accordance with AR 310.25

*Definition of REQUIRED OPERATION involves designation of flight phase and/or subphases with accompanying conditions

Figure B. Handling Qualities Rating Scale

APPENDIX E. TEST DATA

INDEX

<u>Figure</u>	<u>Figure Number</u>
Takeoff Performance	1 through 8
Takeoff Performance Comparison	9
15 Knot Crosswind -15° Flaps	10
15 Knot Crosswind -0° Flaps	11
Static V_{mcg}	12 and 13
Dynamic V_{mcg}	14 and 15
Accelerate-Stop Distance	16 through 21
Engine Response Characteristics	22 and 23
<u>Table</u>	<u>Table Number</u>
Accelerate-Stop Distance Comparison	1
Firewall Temperature Surveys	2 and 3
<u>Photo</u>	<u>Photo Number</u>
Brake Components	1 through 3
Wheel Skid Marks	4 through 17

FIGURE 1
TAKEOFF PERFORMANCE
OV-10 USA S/N 62-5867

GROSS WEIGHT (LB)	LONGITUDINAL C.G. LOCATION (FS)	PRESSURE ALTITUDE (FT)	EXTERNAL CONFIGURATION
16,500	157.5(FWD)	2300	TWO 150 GAL DROP TANKS SLAR, AN/ALQ-147A(V)1

- NOTES: 1. DATA CORRECTED TO STANDARD DAY.
2. □ AND ◇ SYMBOLS DENOTE FLAPS-15.
3. ○ AND △ SYMBOLS DENOTE FLAPS-UP.
4. VYSE = 129 KIAS.

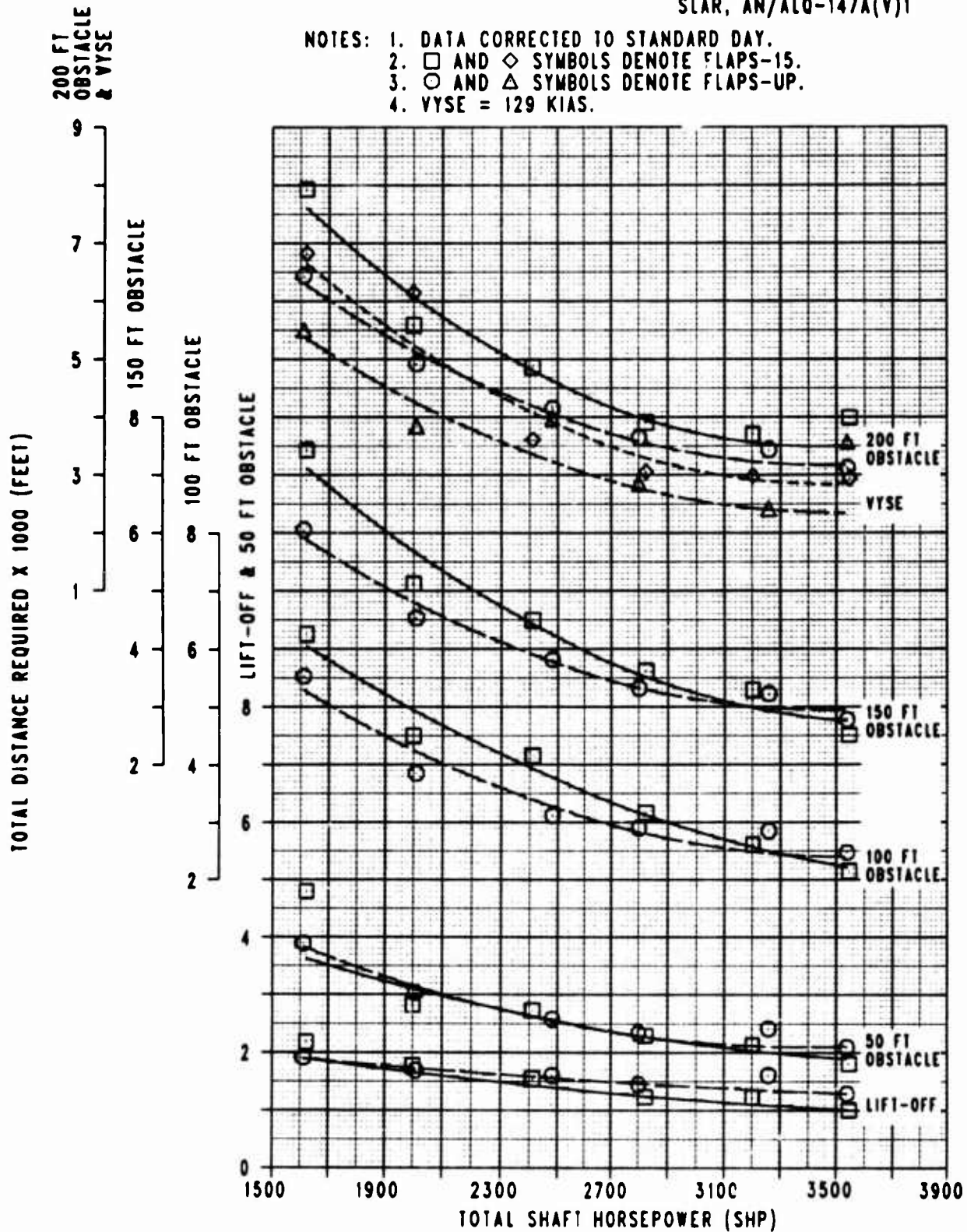


FIGURE 2
TAKEOFF PERFORMANCE
 OV-10 USA S/N 62-5867

GROSS WEIGHT (LB)	LONGITUDINAL C.G. LOCATION (FS)	PRESSURE ALTITUDE (FT)	EXTERNAL CONFIGURATION
16,500	157.5(FWD)	7500	TWO 150 GAL DROP TANKS SLAR, AN/ALO-147A(V)1

- NOTES: 1. DATA CORRECTED TO STANDARD DAY.
 2. □ AND ◇ SYMBOLS DENOTE FLAPS-15.
 3. ○ AND △ SYMBOLS DENOTE FLAPS-UP.
 4. VYSE = 129 KIAS.

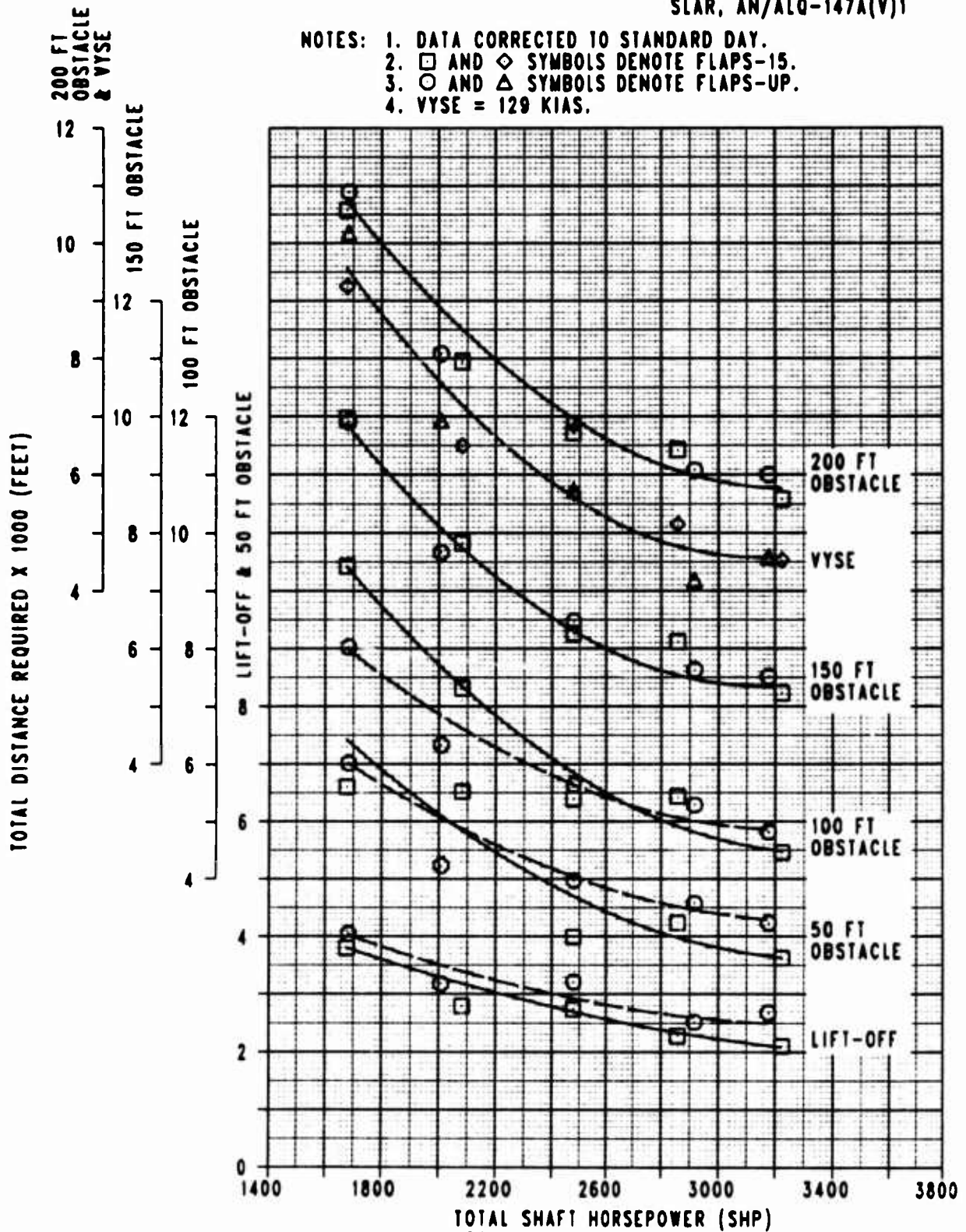


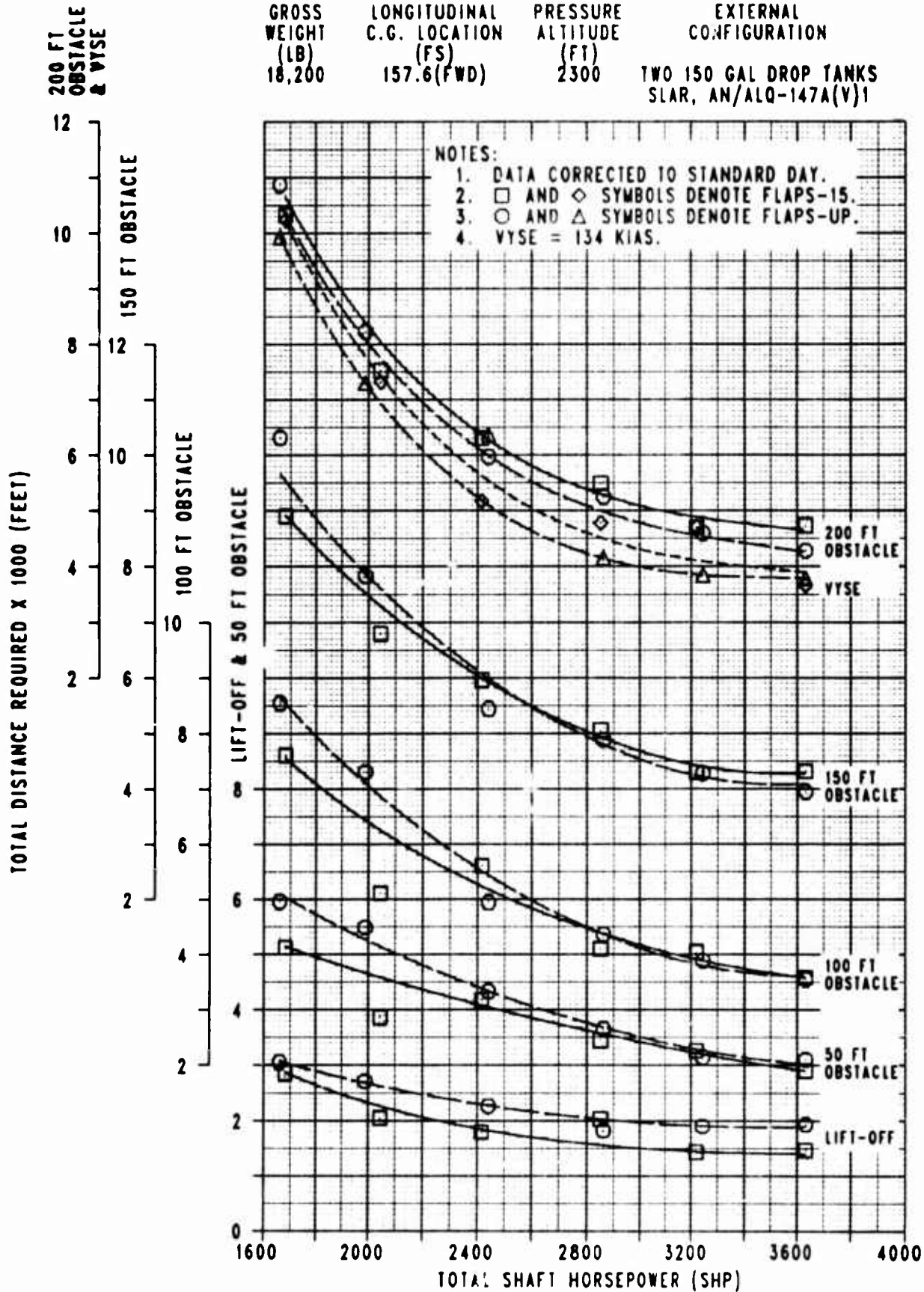
FIGURE 3
TAKEOFF PERFORMANCE
OV-1D USA S/N 62-5867

GROSS
WEIGHT
(LB)
18,200

LONGITUDINAL
C.G. LOCATION
(FS)
157.6(FWD)

PRESSURE
ALTITUDE
(FT)
2300

EXTERNAL
CONFIGURATION
TWO 150 GAL DROP TANKS
SLAR, AN/ALQ-147A(V)1



TWO 150 GAL DROP TANKS
SLAR, AN/ALQ-147A(V)1



FIGURE 5
TAKEOFF PERFORMANCE
OY-1D USA S/N 62-5867

GROSS WEIGHT (LB)	LONGITUDINAL C.G. LOCATION (FS)	PRESSURE ALTITUDE (FT)	EXTERNAL CONFIGURATION
16,500	157.5(FWD)	2300	TWO 150 GAL DROP TANKS SLAR, AN/ALQ-147A(V)1

- NOTES: 1. DATA CORRECTED TO STANDARD DAY.
2. □ SYMBOL DENOTES FLAPS-15.
3. ○ SYMBOL DENOTES FLAPS-UP.
4. VYSE = 129 KIAS.

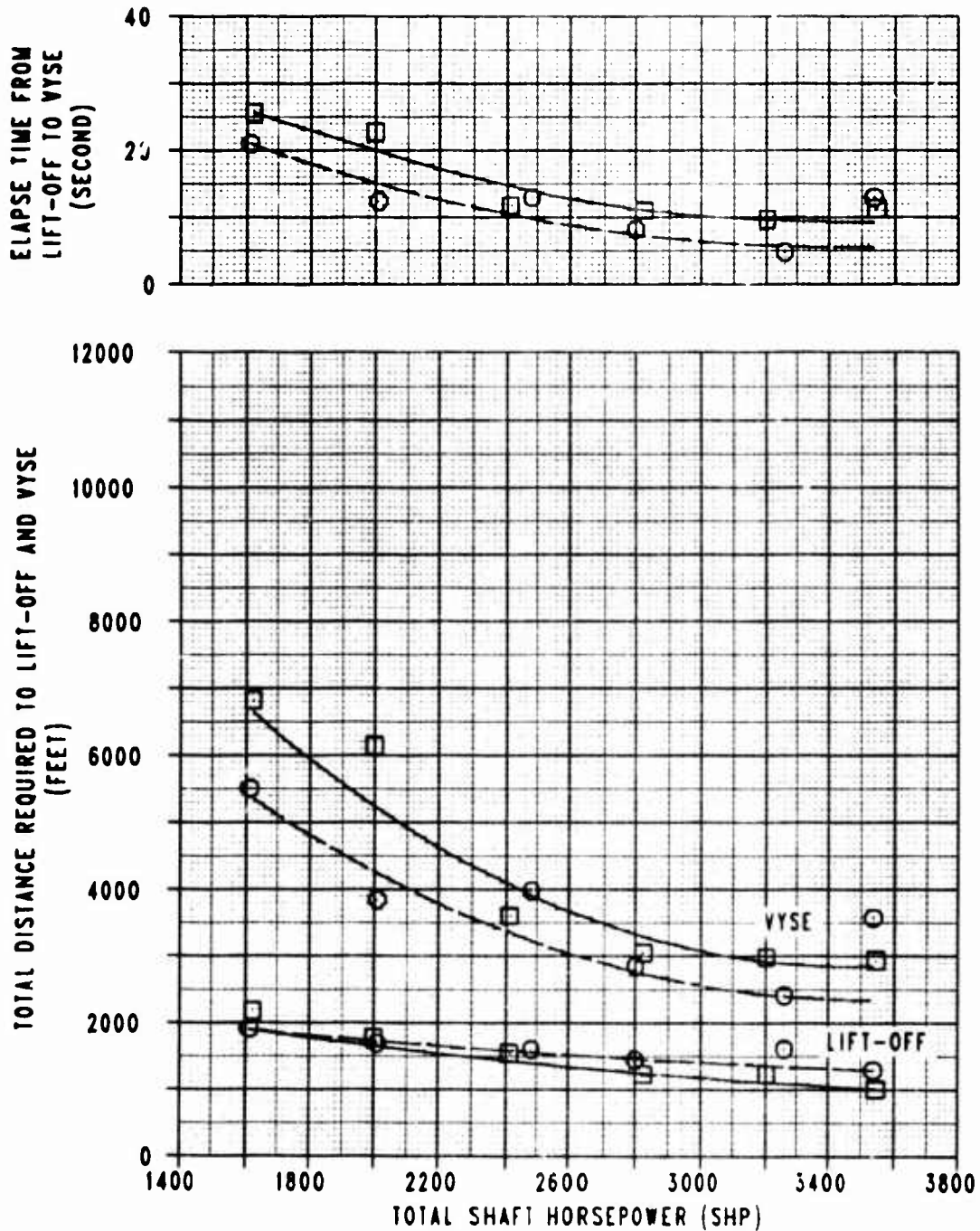


FIGURE 6
TAKEOFF PERFORMANCE
 OV-1D USA S/N 62-5867

GROSS WEIGHT (LB)	LONGITUDINAL C.G. LOCATION (FS)	PRESSURE ALTITUDE (FT)	EXTERNAL CONFIGURATION
18,200	157.6(FWD)	2300	TWO 150 GAL DROP TANKS SLAR, AN/ALQ-147A(V)1

- NOTES: 1. DATA CORRECTED TO STANDARD DAY.
 2. □ SYMBOL DENOTES FLAPS-15.
 3. ○ SYMBOL DENOTES FLAPS-UP.
 4. VYSE = 134 KIAS.

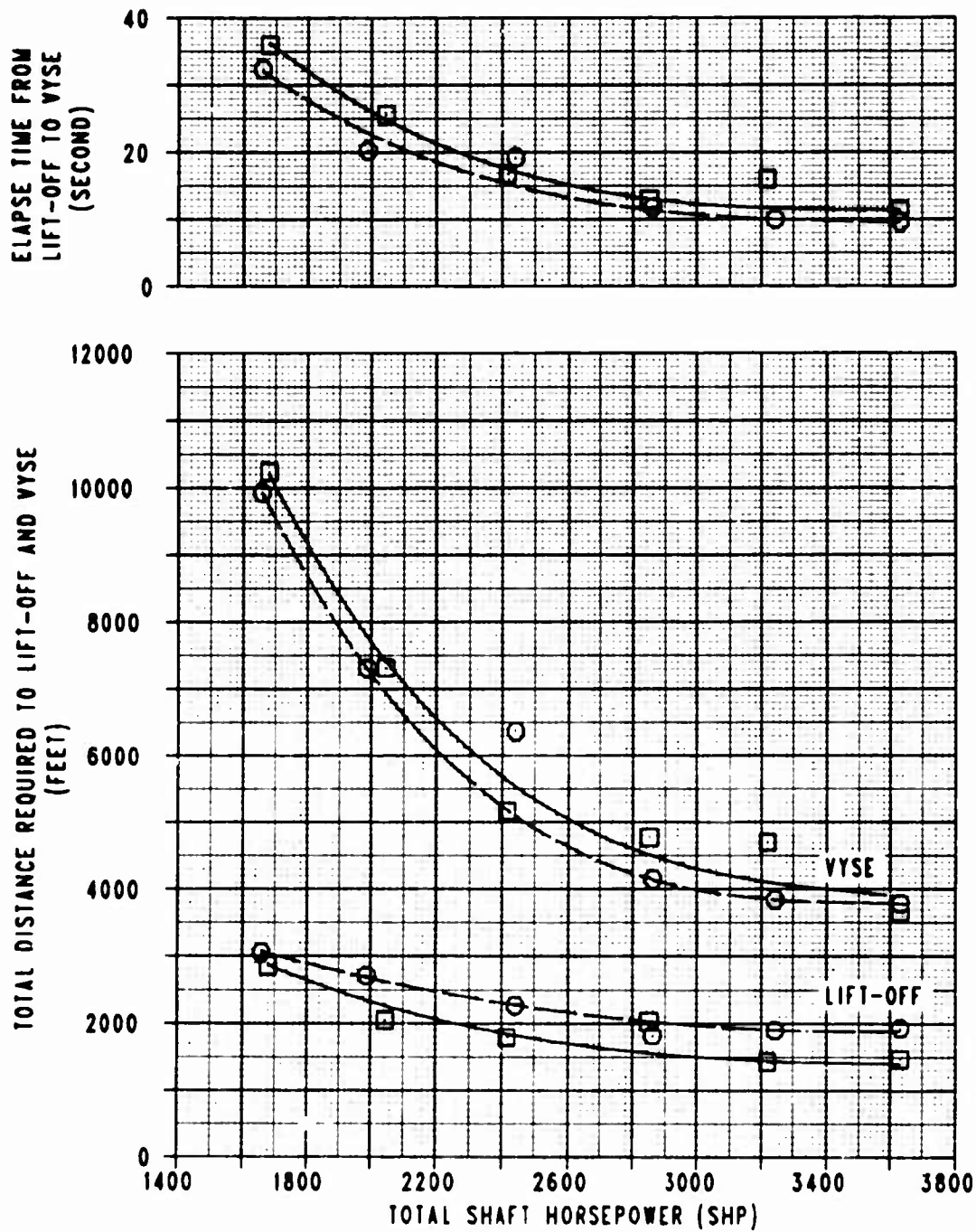


FIGURE 7
TAKEOFF PERFORMANCE
OV-1D USA S/N 62-5867

GROSS WEIGHT (LB)	LONGITUDINAL C.G. LOCATION (FS)	PRESSURE ALTITUDE (FT)	EXTERNAL CONFIGURATION
16,500	157.5(FWD)	7500	TWO 150 GAL DROP TANKS SLAR, AN/ALQ-147A(V)1

NOTES: 1. DATA CORRECTED TO STANDARD DAY.
2. □ SYMBOL DENOTES FLAPS-15.
3. ○ SYMBOL DENOTES FLAPS-UP.
4. VYSE = 129 KIAS.

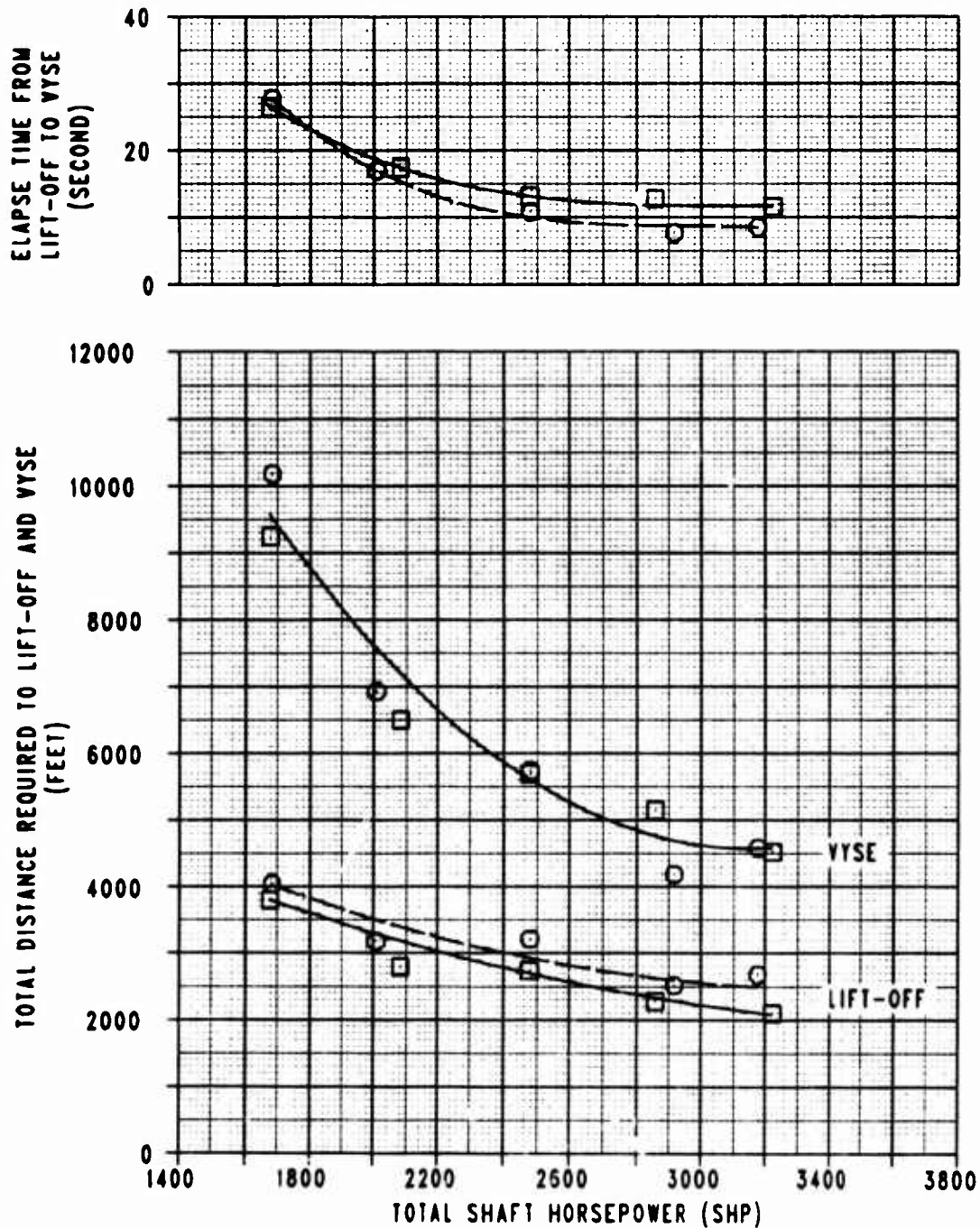


FIGURE 8
TAKEOFF PERFORMANCE
OV-10 USA S/N 62-5867

GROSS WEIGHT (LB)	LONGITUDINAL C.G. LOCATION (FS)	PRESSURE ALTITUDE (FT)	EXTERNAL CONFIGURATION
18,200	157.6(FWD)	7500	TWO 150 GAL DROP TANKS SLAR, AN/ALQ-147A(V)1

- NOTES: 1. DATA CORRECTED TO STANDARD DAY.
2. □ SYMBOL DENOTES FLAPS-15.
3. ○ SYMBOL DENOTES FLAPS-UP.
4. VYSE = 134 KIAS.

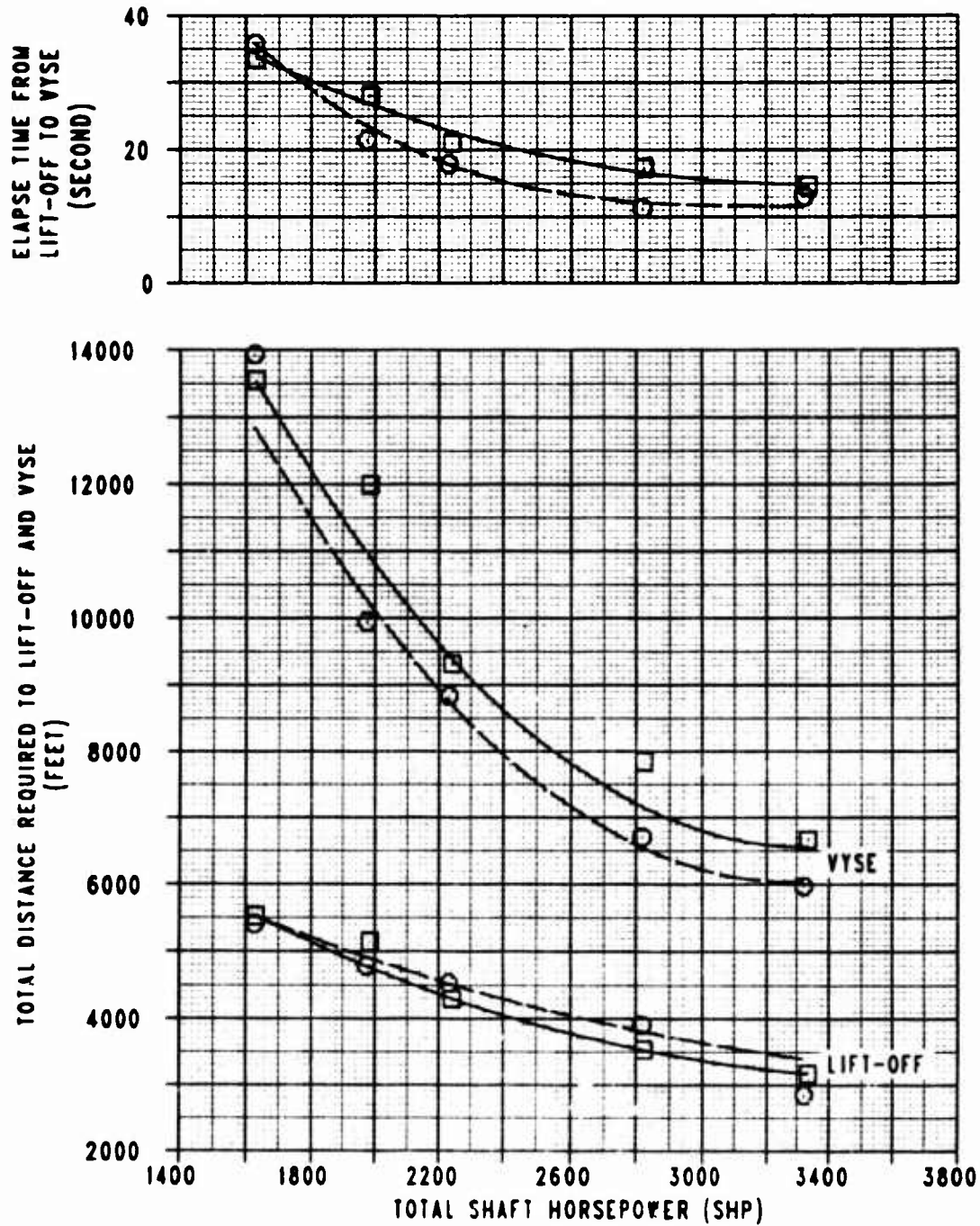


FIGURE 9
TAKEOFF PERFORMANCE COMPARISON
OV-10 USA S/N 62-867

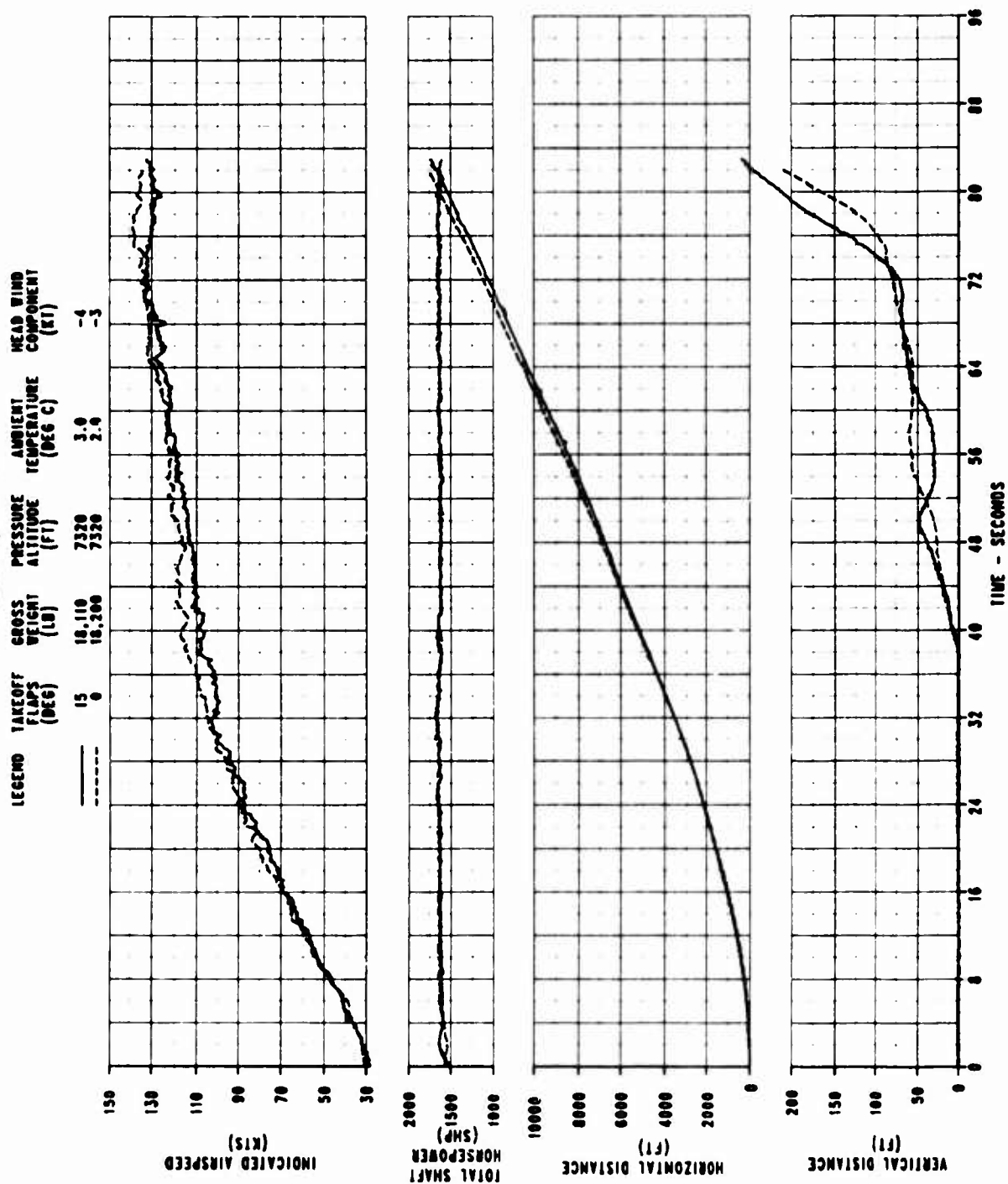


FIGURE 10
 15 KNOT RIGHT CROSSWIND TAKEOFF WITH FLAPS-15
 OV-10 USA S/N 62-5867
 GROSS WEIGHT (LB) 15,360
 LONGITUDINAL CG LOCATION (FS) 159.4(WID)
 PRESSURE ALTITUDE (FT) 2200
 AMBIENT TEMPERATURE (DEG C) 13.0
 ENGINE TORQUE (%) 100

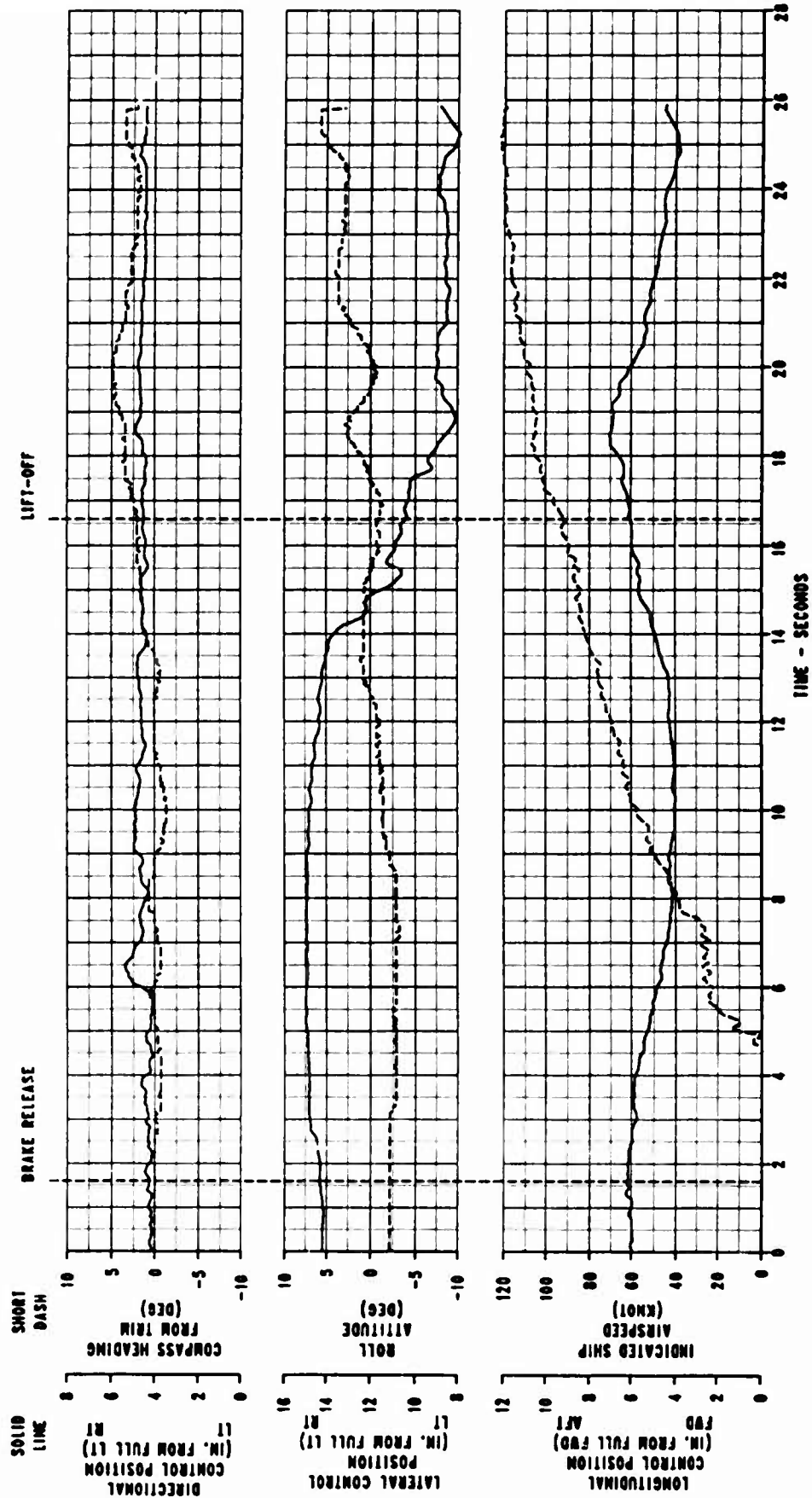


FIGURE 11
15 KNOT RIGHT CROSSWIND TAKEOFF WITH FLAPS-UP

09-19 USA S/N 02-5067
GROSS WEIGHT (LB) 15,560
LONGITUDINAL CG LOCATION (FS) 159.5(MID)
PRESSURE ALTITUDE (FT) 2200
AMBIENT TEMPERATURE (DEG C) 10.5
ENGINE TORQUE (S) 100

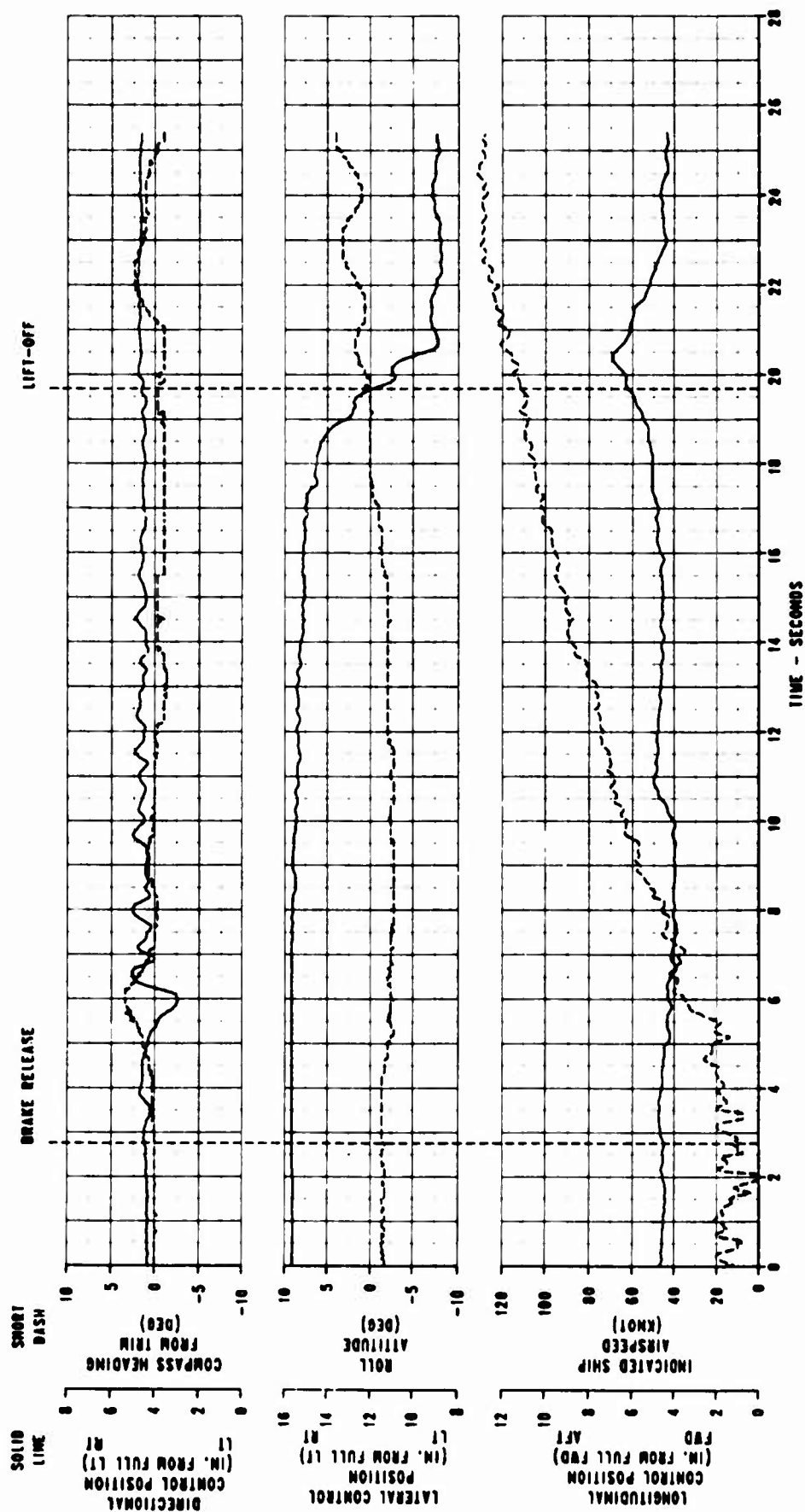


FIGURE 12
STATIC SINGLE ENGINE MINIMUM CONTROL GROUND AIRSPEED
09-10 USA S/N 62-5067

GROSS WEIGHT (LB)	LONGITUDINAL CG LOCATION (FS)	PRESSURE ALTITUDE (FT)	AMBIENT TEMPERATURE (DEG C)	FLAPS POSITION (DEG)
18,400	100.8(MID)	2000	7.5	15

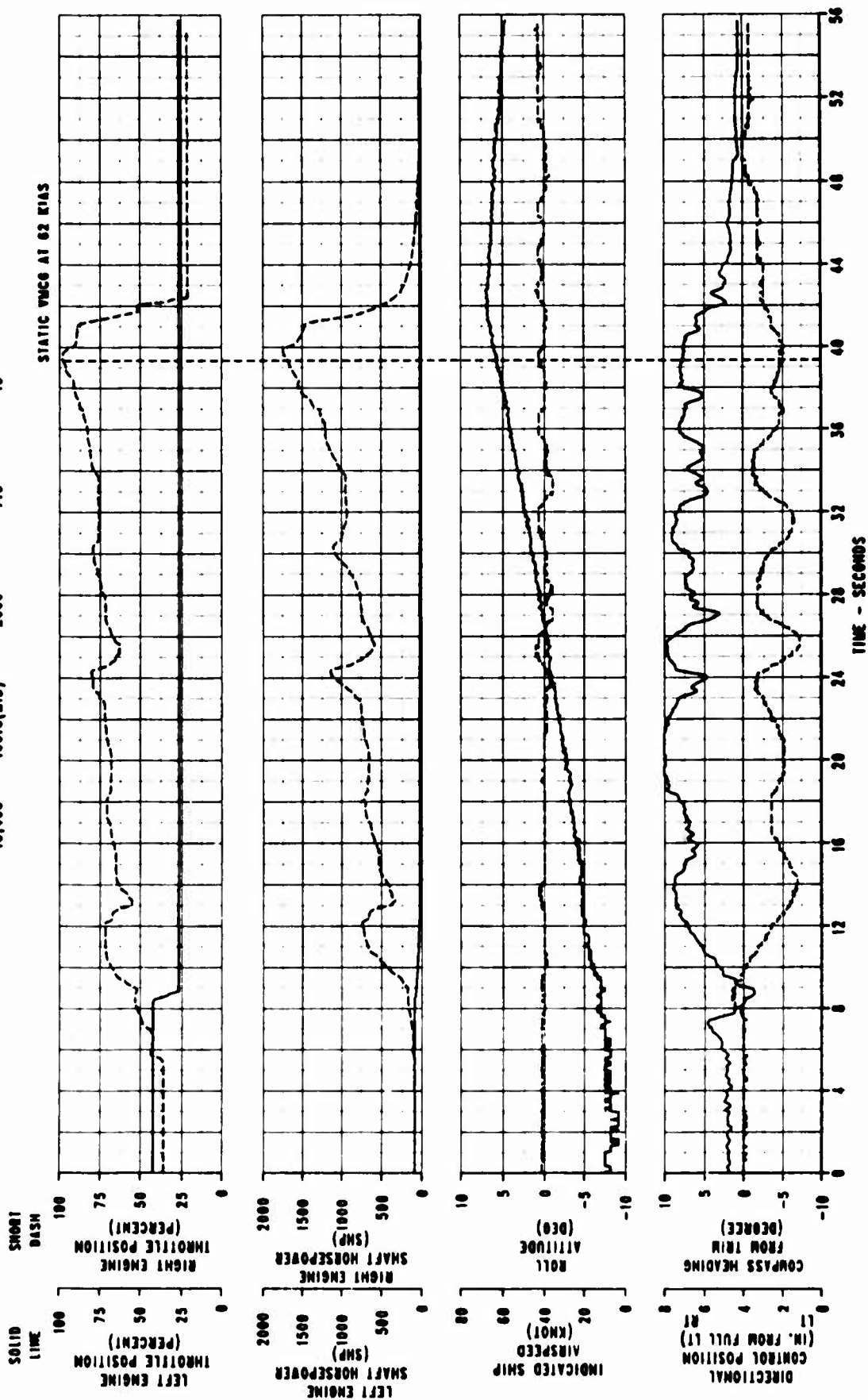


FIGURE 13
STATIC SINGLE ENGINE MINIMUM CONTROL GROUND AIRSPEED

OV-10 USA S/N 62-5867
GROSS WEIGHT (LB) 18,270
LONGITUDINAL CB LOCATION (FS) 160.7 (MID)
PRESSURE ALTITUDE (FT) 2000
AMBIENT TEMPERATURE (DEG C) 8.0
FLAPS POSITION (DEG) 0

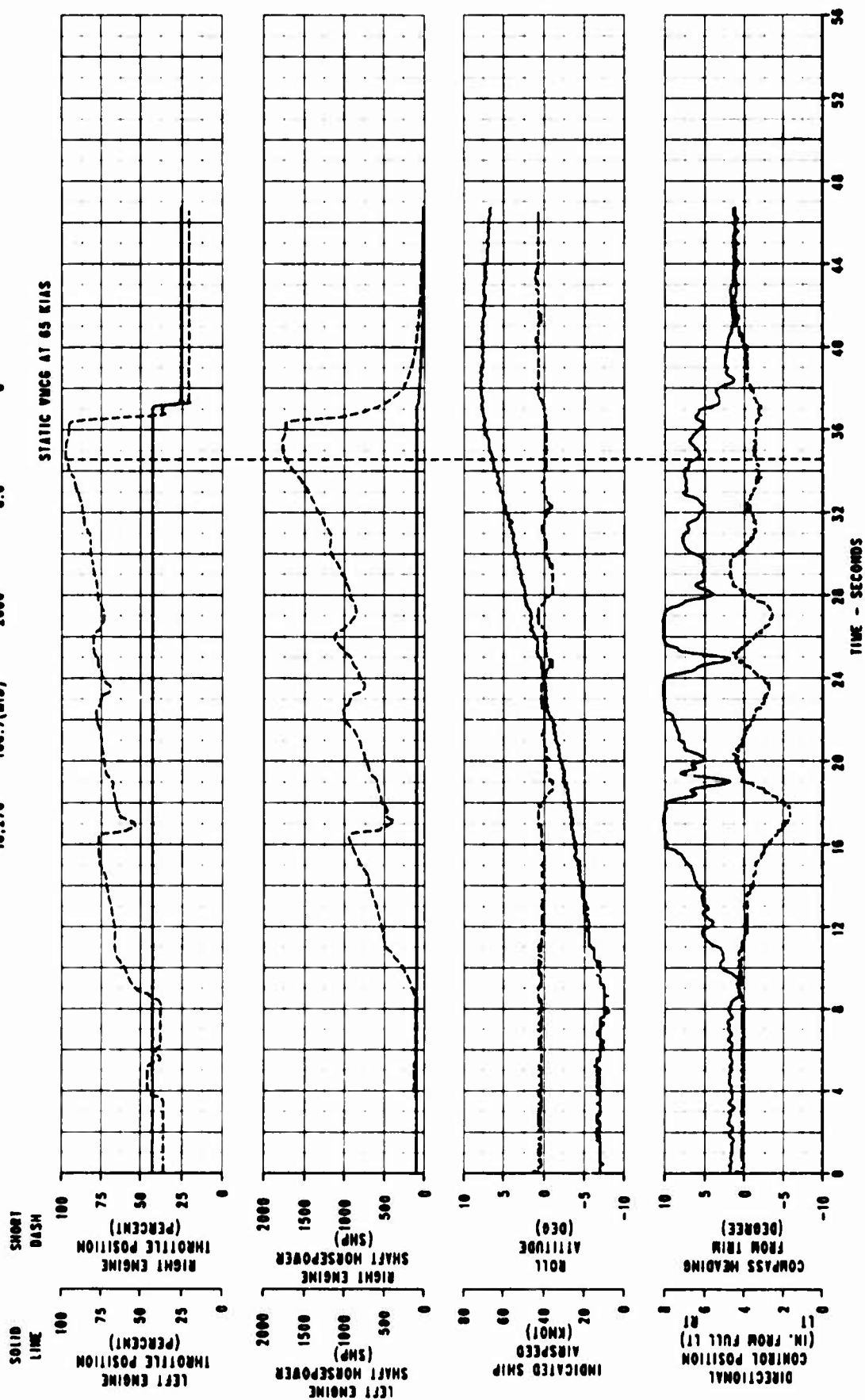


FIGURE 14
DYNAMIC SINGLE ENGINE MINIMUM CONTROL GROUND AIRSPEED
OV-10 USA S/N 62-5887

GROSS WEIGHT (LB) 10,300
LONGITUDINAL CG LOCATION (FS) 100.7 (MID)
PRESSURE ALTITUDE (FT) 2000
AMBIENT TEMPERATURE (DEG C) 7.5
FLAPS POSITION (DEG) 15

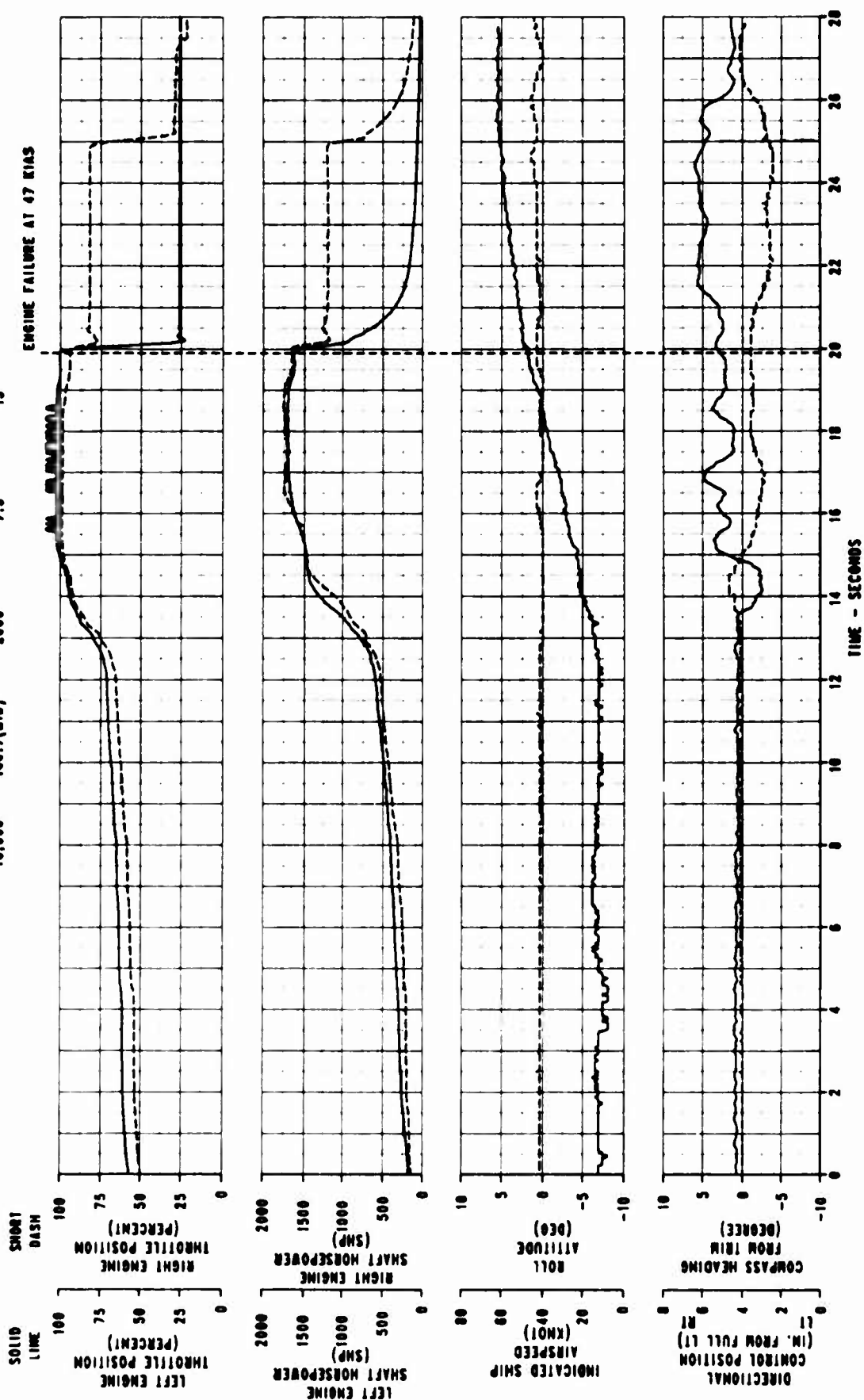


FIGURE 15
DYNAMIC SINGLE ENGINE MINIMUM CONTROL GROUND AIRSPEED

OV-10 USA S/M 62-5867

GROSS WEIGHT (LB)	LONGITUDINAL CG LOCATION (FS)	PRESSURE ALTITUDE (FT)	Ambient Temperature (DEG C)	Flaps Position (DEG)
10,130	160.7 (MID)	2000	9.5	0

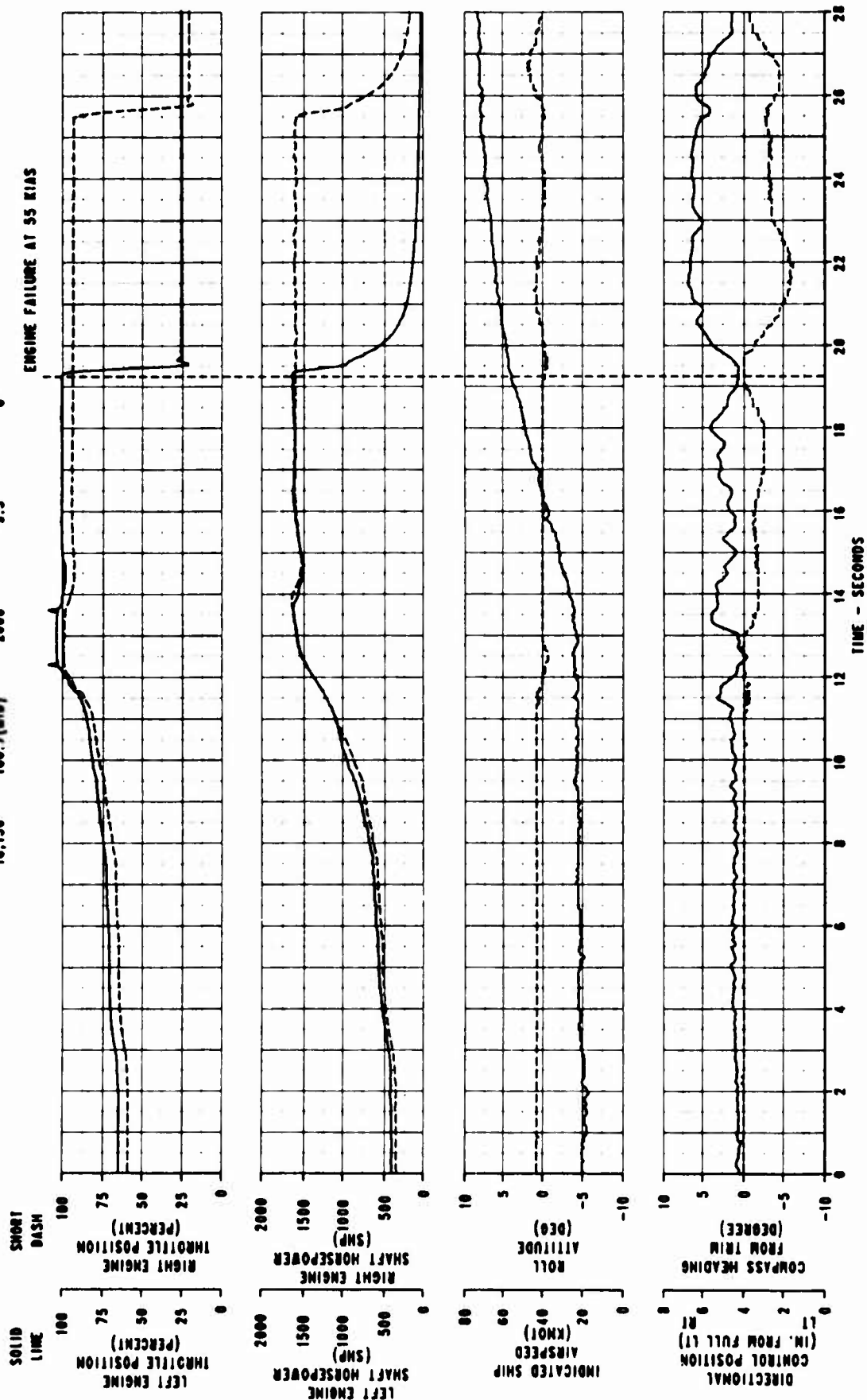


FIGURE 16
ACCELERATE STOP DISTANCE

OV-10 USA S/N 62-5867
 AMBIENT TEMPERATURE (DEG C) 10.0
 HEAD WIND COMPONENT (KT) 4
 FLAPS POSITION (DEG) 0
 AERODYNAMIC BRAKING YES
 SPEED BRAKES YES
 WHEEL BRAKES YES

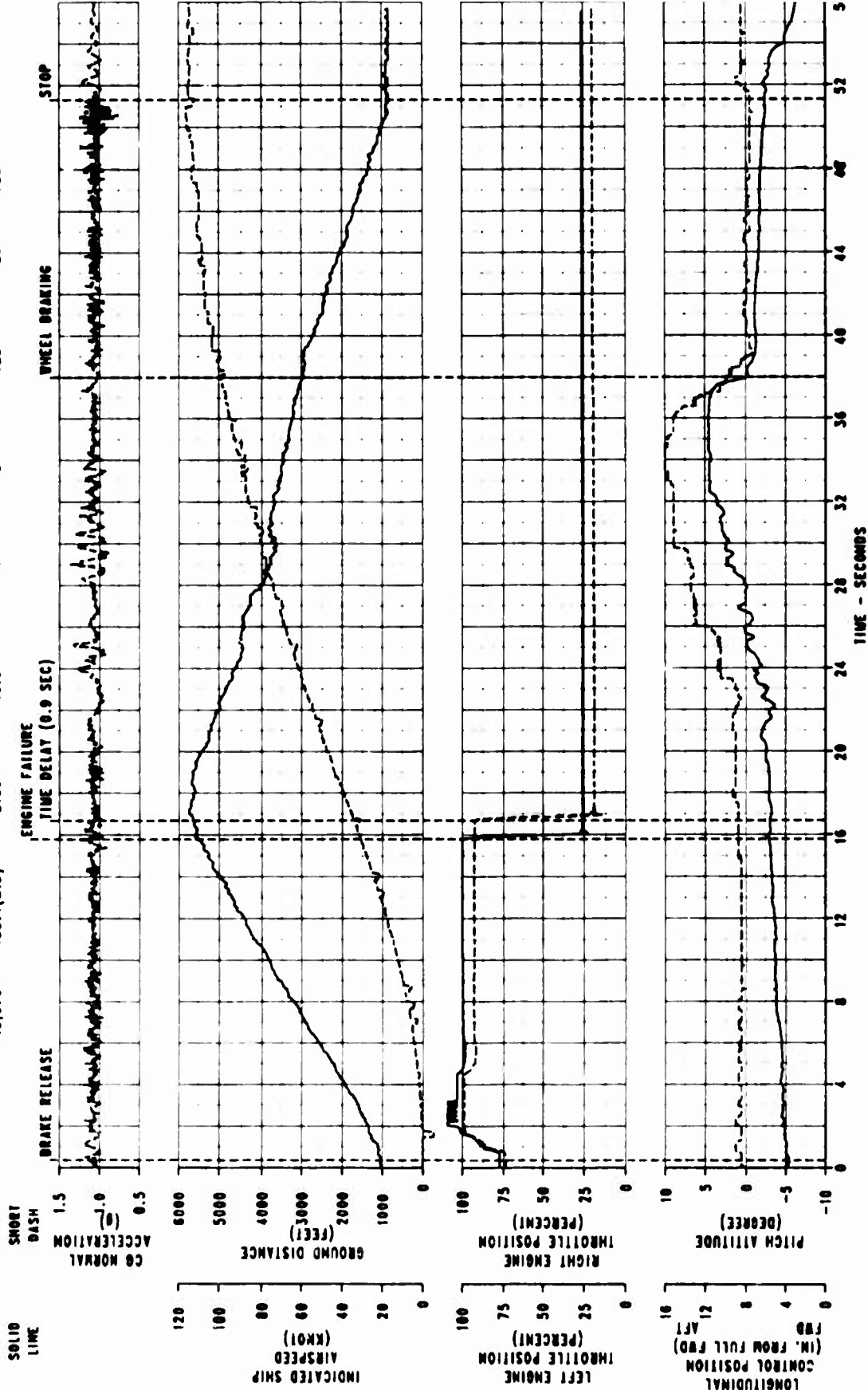


FIGURE 17
ACCELERATE STOP DISTANCE

OV-10 USA S/N 82-3867

GROSS WEIGHT (LB) 14,810
LONGITUDINAL CG LOCATION (FS) 158.4 (W/D)
PRESSURE ALTITUDE (FT) 2100
AMBIENT TEMPERATURE (DEG C) 14.5
HEAD WIND COMPONENT (KT) 1
FLAPS POSITION (DEG) 15
AERODYNAMIC BRAKING YES
SPEED BRAKES YES
WHEEL BRAKES YES

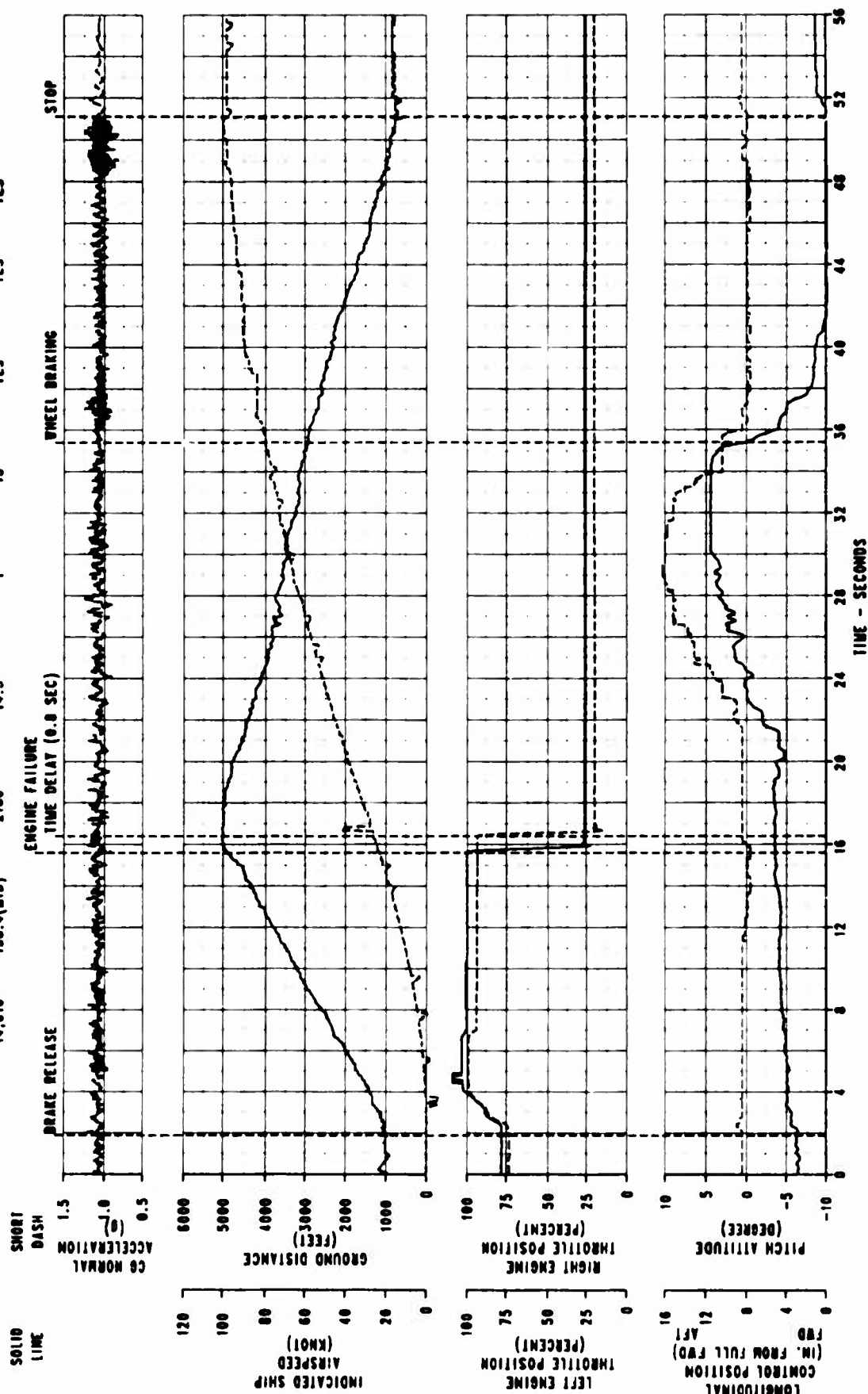


FIGURE 10
ACCELERATE STOP DISTANCE

OV-10 USA S/N 82-5807

GROSS WEIGHT (LB)	16,100	LONGITUDINAL CG LOCATION (FS)	100.4 (MID)	PRESSURE ALTITUDE (FT)	2000	AMBIENT TEMPERATURE (DEG C)	5.0	HEAD WIND COMPONENT (KT)	-2	FLAPS POSITION (DEG)	15	AERODYNAMIC BRAKING	YES	SPEED BRAKES	YES	WHEEL BRAKES	YES
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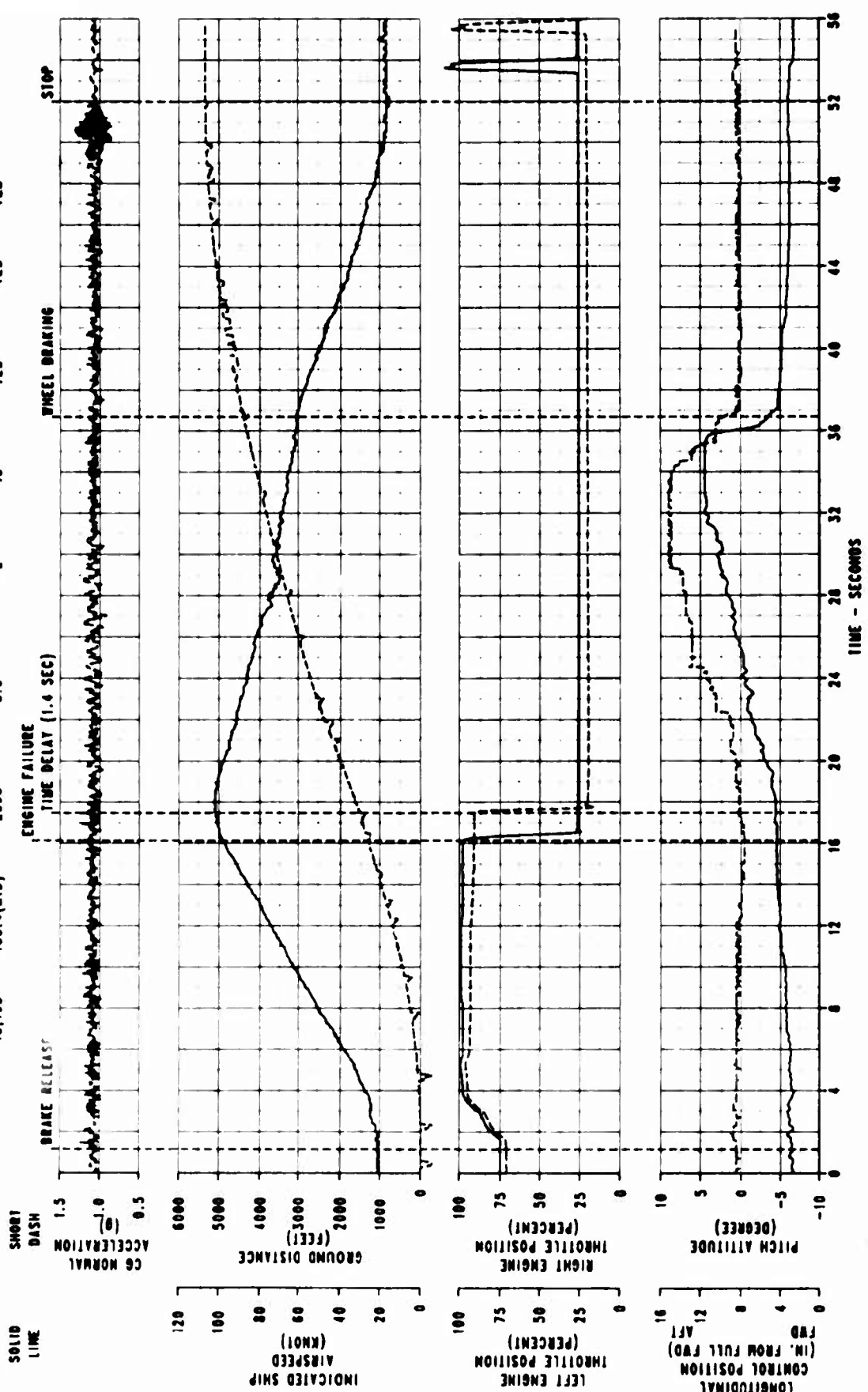


FIGURE 19
ACCELERATE STOP DISTANCE
OV-10 USA S/N 62-5867

GROSS WEIGHT (LB) 16,330
LONGITUDINAL CG LOCATION (FS) 160.4 (WID)
PRESSURE ALTITUDE (FT) 2100
AMBIENT TEMPERATURE (DEG C) 4.5
HEAD WIND COMPONENT (KT) 0
FLAPS POSITION (DEG) 0
AERODYNAMIC BRAKING YES
SPEED BRAKES YES
WHEEL BRAKES YES

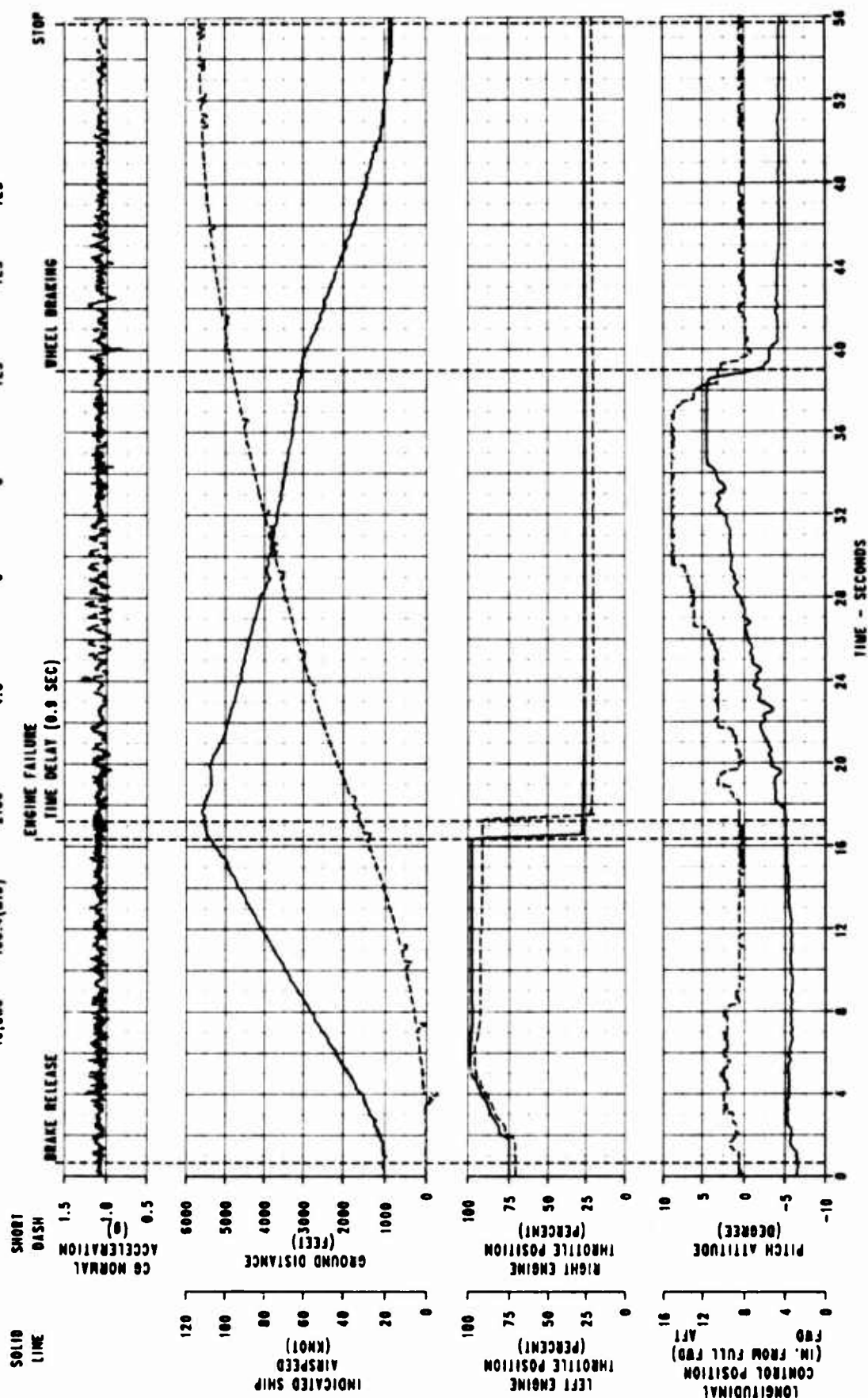


FIGURE 20
ACCELERATE STOP DISTANCE
09-10 USA S/N 62-3067

GROSS WEIGHT (LB) 10,230
LONGITUDINAL CG LOCATION (FS) 100.7(MID)
PRESSURE ALTITUDE (FT) 2150
AMBIENT TEMPERATURE (DEG C) 3.5
HEAD WIND COMPONENT (KT) 0
FLAPS POSITION (DEG) 15
AERODYNAMIC BRAKING YES
SPEED BRAKES YES
WHEEL BRAKES YES

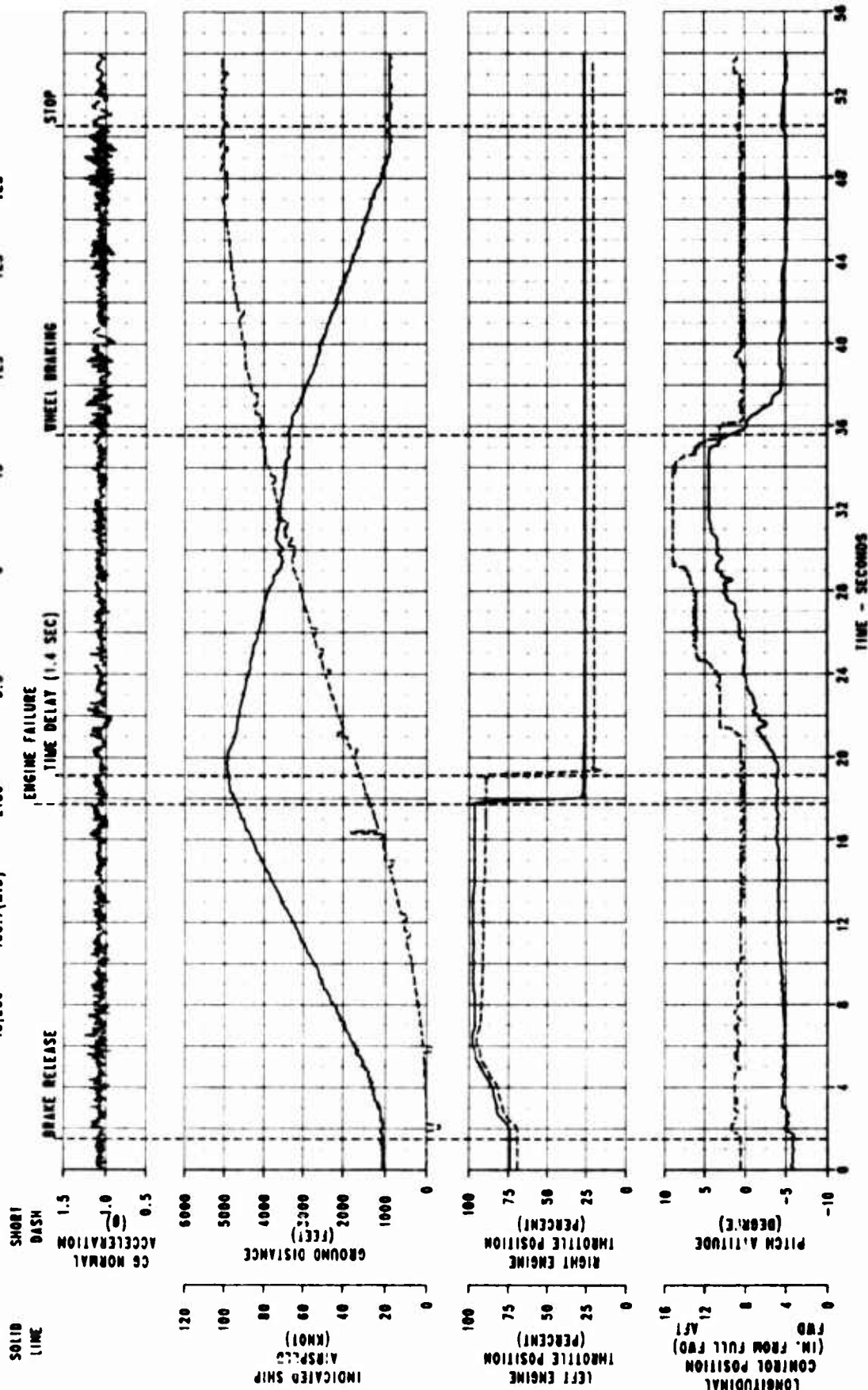


FIGURE 21
ACCELERATE STOP DISTANCE

OV-10 USA S/N 62-3067

GROSS WEIGHT (LB) 10,300
LONGITUDINAL CG LOCATION (FS) 100.0 (MID)
PRESSURE ALTITUDE (FT) 2170
AMBIENT TEMPERATURE (DEG C) 3.0
HEAD WIND COMPONENT (KT) 0
FLAPS POSITION (DEG) 0
AERODYNAMIC BRAKING YES
SPEED BRAKES YES
WHEEL BRAKES YES

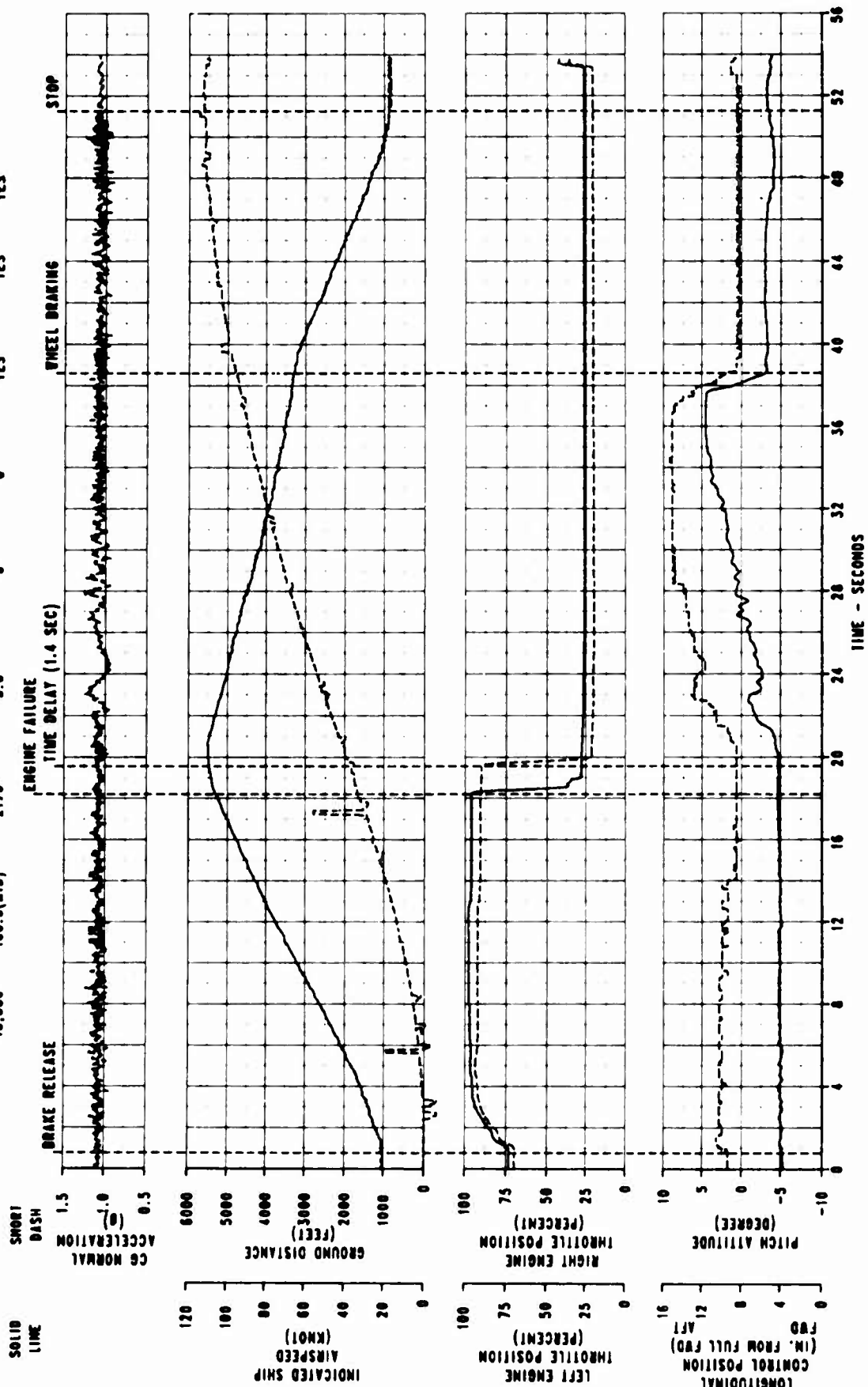


FIGURE 22
ENGINE RESPONSE TO THROTTLE TRANSIENT
 OV-10 USA S/N 82-5867

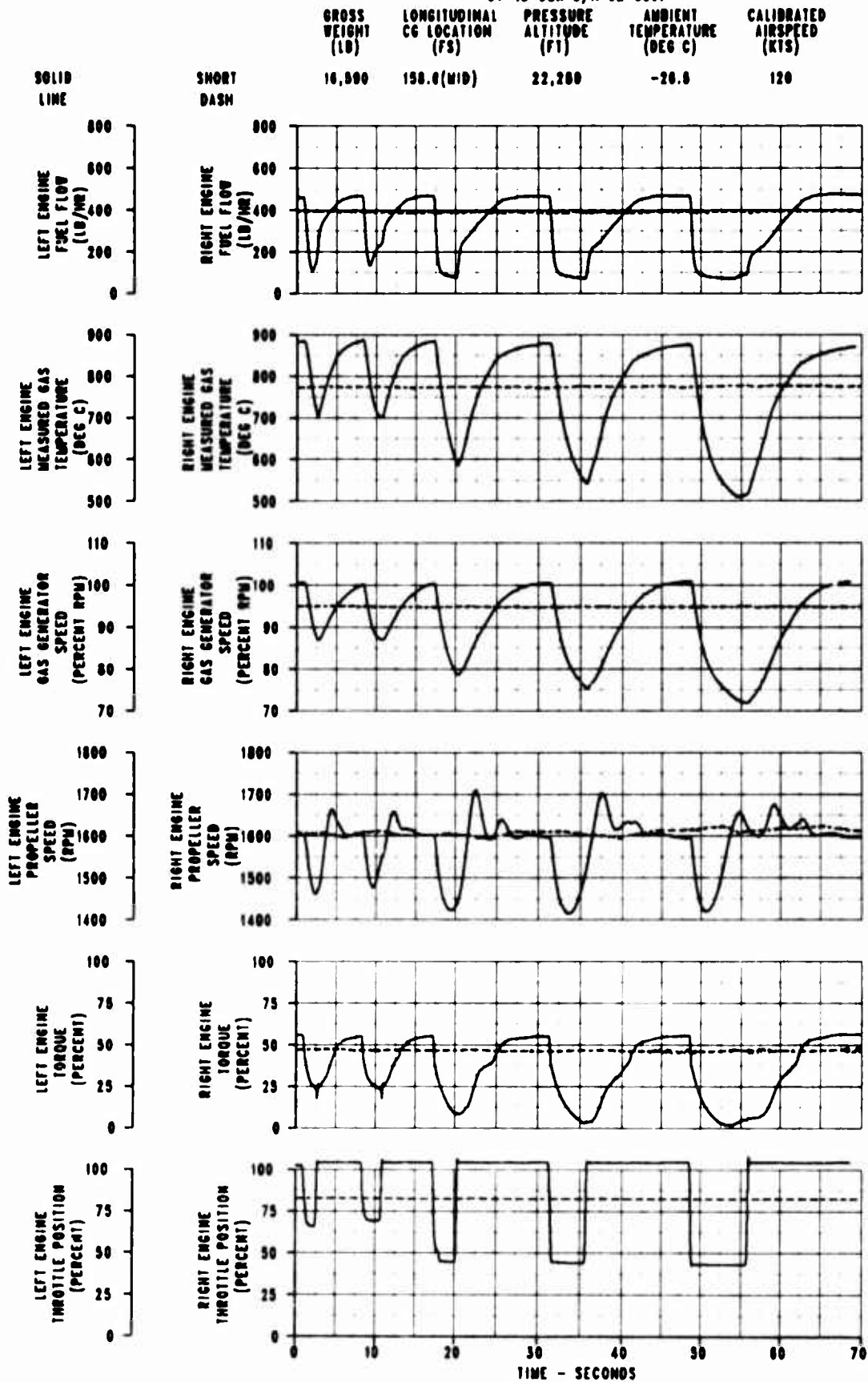


FIGURE 23
ENGINE RESPONSE TO THROTTLE TRANSIENT
OV-10 USA S/N 62-5867

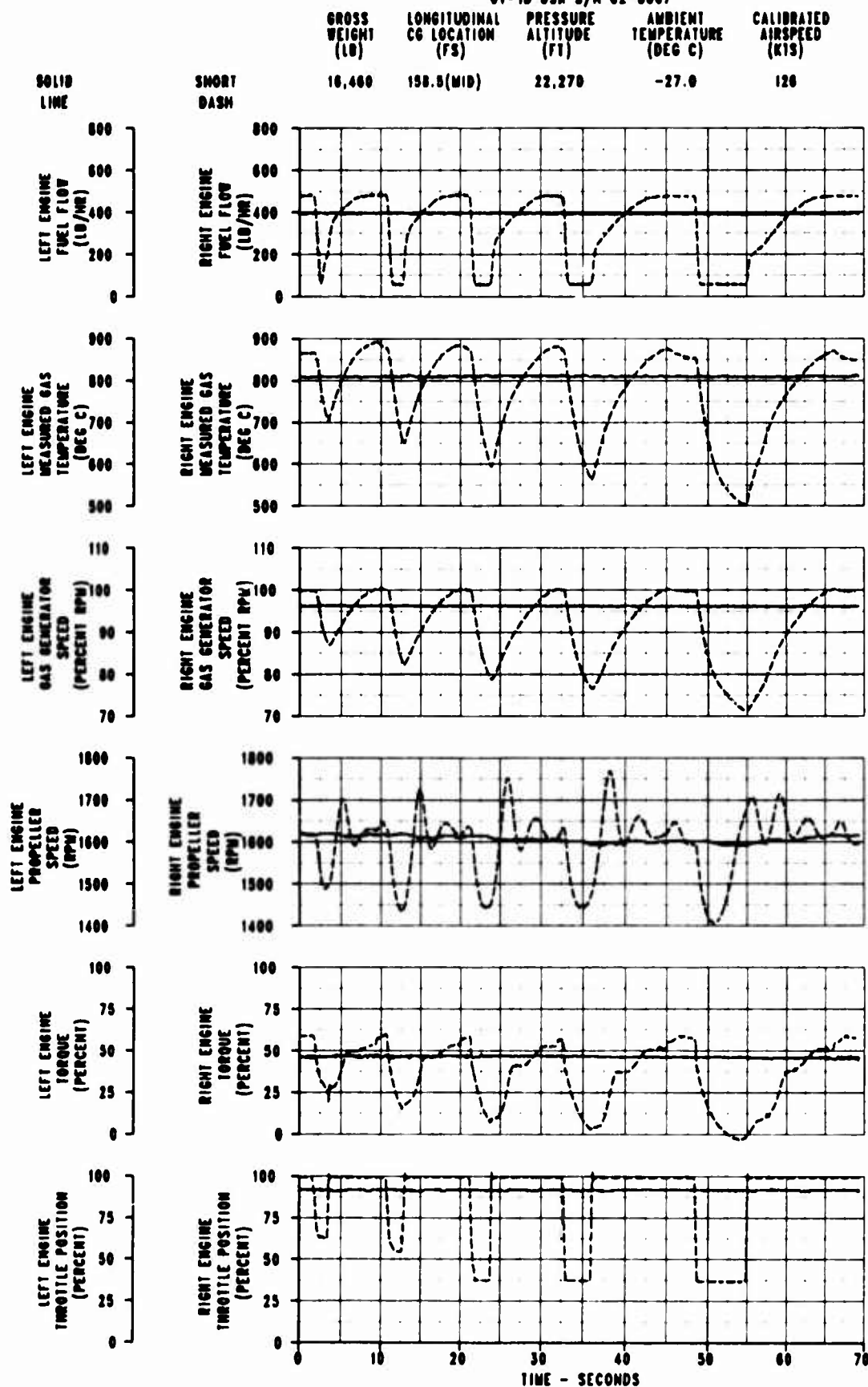


Table 1. Accelerate-Stop Distance Comparison

Gross Weight (lb)	Flaps Position (deg)	Pressure Altitude (ft)	Ambient Temperature (deg C)	Head Wind Component (knot)	Handbook ¹ Stop Distance (ft)	Test Result ² Stop Distance (ft)
14,810	15	2160	14.5	1	4130	4915
15,070	0	2150	10.0	4	N/A	5735
16,190	15	2090	5.0	-2	4450	5340
16,330	0	2100	4.5	0	N/A	5645
18,230	15	2150	3.5	0	5180	5070
18,380	0	2170	3.0	0	N/A	5615

NOTES:

¹Accelerate-stop distance obtained from figure 7-11 of TM 55-1510-213-10 for flaps-15 with wheel braking only.

²Test results applying flaps-45, speed brakes, aerodynamic and wheel braking.

Table 2. Firewall Temperature Survey Without LSSS Installed

Engine Torque (%)	Gas Producer Speed (% rpm)	Measured Gas Temperature (deg C)	Propeller Speed (rpm)	Ambient Temperature (deg C)	Calibrated Airspeed (knot)	Thermocouple Position					
						0	1	2	3	4	5
6	35	479	606	1.0	0	56	55	25	40	41	35
14	56	485	893	1.0	0	60	60	28	41	42	38
24	70	507	1169	1.0	0	62	62	32	40	41	39
34	76	527	1389	1.0	0	64	64	35	40	41	41
44	80	572	1564	0.0	0	70	70	40	41	42	45
54	84	628	1681	0.0	0	77	76	42	45	46	50
64	85	656	1666	0.0	0	84	83	46	52	51	56
73	88	684	1676	0.0	0	88	88	49	58	55	59
83	90	709	1669	0.0	0	93	95	52	63	59	59
93	92	735	1669	0.0	0	100	105	56	67	62	61
103	94	760	1661	0.0	0	107	112	61	72	67	66
114	96	789	1651	0.0	0	114	119	67	75	72	76
123	98	814	1659	0.0	0	122	127	75	79	77	84
113	96	786	1645	0.0	0	126	131	80	83	79	86
102	93	762	1639	0.0	0	126	131	82	84	79	86
92	91	735	1640	0.0	0	125	130	81	82	79	86
82	89	710	1642	0.0	0	122	127	78	79	72	77
72	87	685	1628	0.0	0	118	122	76	75	69	74
63	85	658	1629	0.0	0	115	120	73	70	65	71
55	83	629	1643	0.0	0	113	117	69	70	66	71
44	80	581	1549	0.0	0	108	110	67	61	59	67
34	76	531	1385	0.0	0	96	97	63	52	52	61
23	71	502	1179	0.0	0	91	92	61	50	50	59
13	58	498	926	0.0	0	87	86	60	49	50	58
4	34	501	615	1.0	0	84	84	60	51	52	56

NOTE:

Thermocouple positions 0, 1, 2, 3, 4, 5 represent 12, 12, 9, 6, 6, 3 o'clock positions respectively.

Table 3. Firewall Temperature Survey with LSSS Installed

Engine Torque (%)	Gas Producer Speed (% rpm)	Measured Gas Temperature (deg C)	Propeller Speed (rpm)	Ambient Temperature (deg C)	Calibrated Airspeed (knot)	Thermocouple Position					
						0	1	2	3	4	5
5	34	513	591	6.0	0	113	124	118	159	146	91
11	54	503	861	6.0	0	84	116	95	134	116	65
23	72	528	1178	6.0	0	70	109	76	98	83	49
34	78	560	1416	7.0	0	63	98	68	76	65	43
44	82	606	1590	7.0	0	60	83	63	60	54	42
54	85	644	1637	7.0	0	71	73	70	60	56	54
63	86	676	1625	7.0	0	121	68	121	96	107	125
73	89	706	1632	6.0	0	182	70	202	206	232	211
83	91	732	1632	6.0	0	197	86	251	269	299	257
92	93	757	1634	6.0	0	228	249	255	296	324	265
92	93	755	1628	6.0	0	245	248	273	338	349	270
82	91	726	1613	6.0	0	225	231	304	328	333	262
73	88	702	1615	6.0	0	203	209	268	303	303	245
63	86	672	1608	6.0	0	186	193	215	248	243	220
53	85	643	1617	6.0	0	119	135	111	162	148	102
44	82	606	1579	6.0	0	57	69	49	98	100	43
33	78	559	1418	6.0	0	32	40	117	72	70	23
24	73	526	1213	6.0	0	28	34	91	62	59	22
12	58	510	919	6.0	0	32	38	70	62	60	29
3	34	517	614	6.0	0	41	47	71	69	68	39
13	73	503	1589	-6.0	90	40	40	44	74	72	68
23	77	547	1613	-6.0	90	40	45	57	66	62	38
33	80	584	1603	-6.0	90	40	40	45	50	66	63
43	83	637	1615	-6.0	90	59	61	74	51	72	69
54	86	680	1604	-6.0	90	148	140	158	182	204	143
63	89	712	1614	-6.0	90	208	210	216	269	294	230
72	91	744	1604	-6.0	90	213	214	219	309	335	268
70	88	696	1454	-6.0	196	62	62	67	107	95	86
81	91	728	1445	-6.0	196	72	78	73	107	109	48
90	93	762	1463	-6.0	196	92	91	100	222	229	61
101	96	795	1454	-6.0	196	104	104	114	240	241	68
112	99	834	1452	-6.0	196	114	114	125	285	299	71

NOTE:

Thermocouple positions 0, 1, 2, 3, 4, 5 represent 12, 12, 9, 6, 6, 3 o'clock positions respectively.



Photo 1. Damaged Center Carrier of Main Wheel Brakes

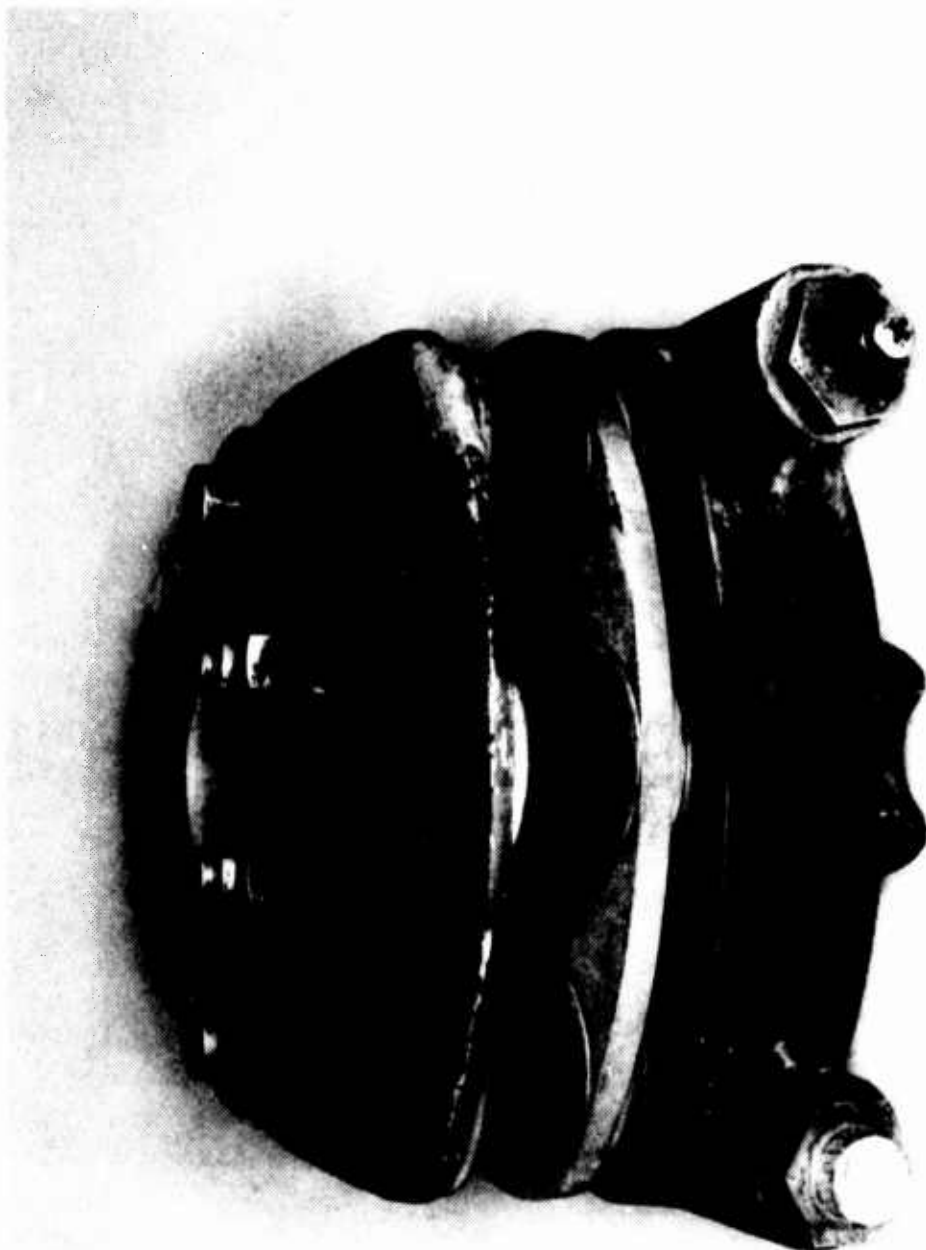


Photo 2. Damaged Brake Assembly

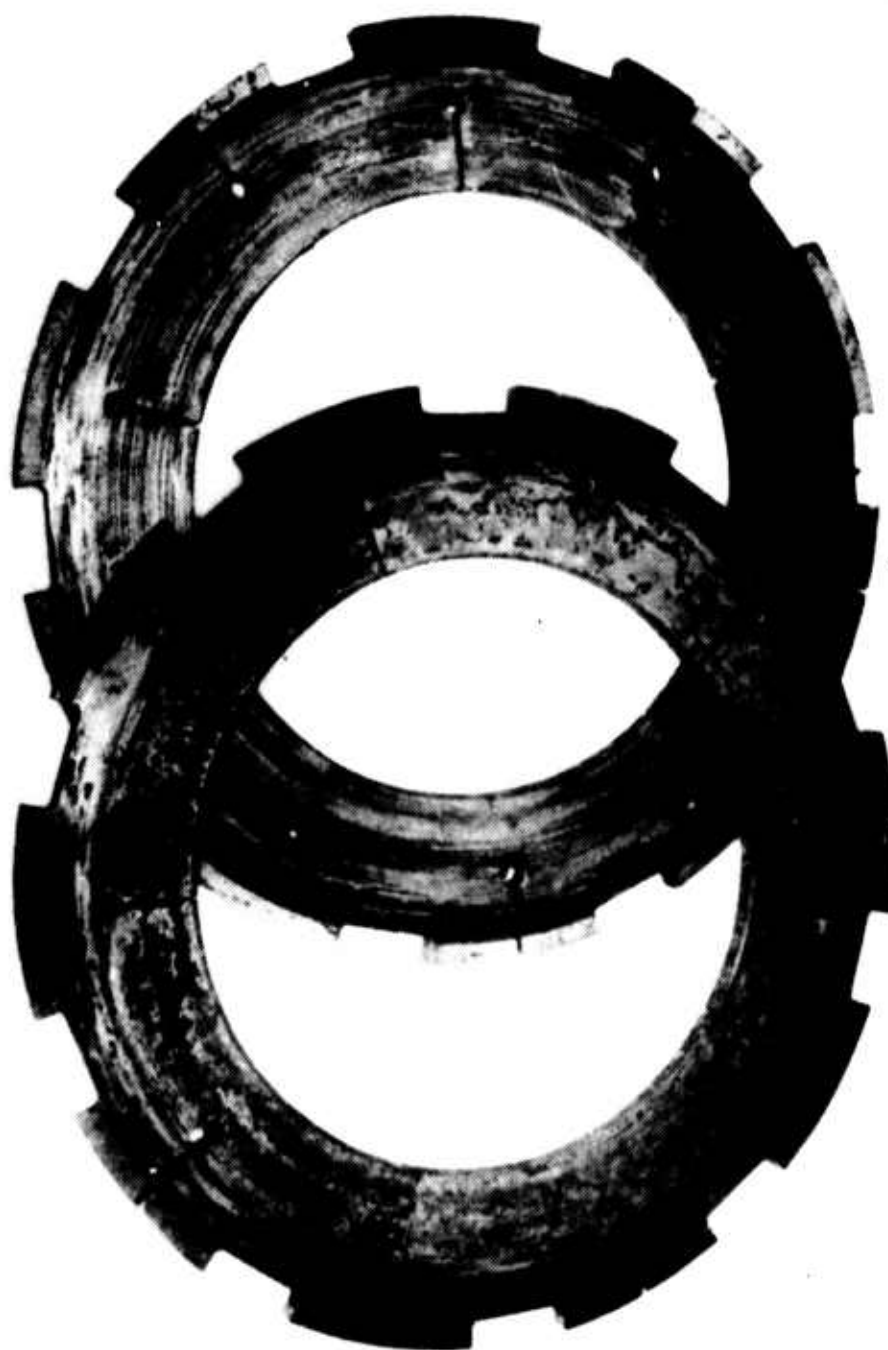


Photo 3. Damaged Dual Brake Discs



Photo 4. Skid Marks During Accelerate-Stop Test

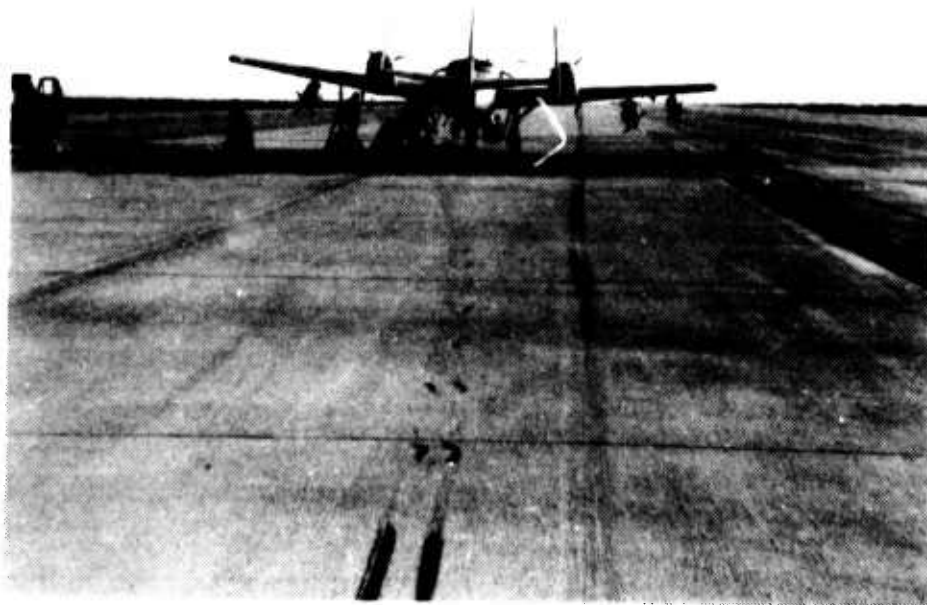


Photo 5. Tire Marks of Blown Tire During Accelerate-Stop Test

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